

WST2

Washington State Technology Transfer



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**Washington State
Department of Transportation**

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Washington State Technology Transfer Center
310 Maple Park Avenue SE
PO Box 47390
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Please contact Larry Schofield, P.E., Technology Transfer Engineer,
PO Box 47390, Olympia, WA 98504-7390; phone (360) 705-7380,
fax (360) 705-6858, or e-mail schofil@wsdot.wa.gov.

Editor reserves the right to refuse to publish and to edit articles
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The opinions expressed in articles are not necessarily those
of the editor.

Cover photo by Dave Burkey: *A stretch of U.S. 395 near Deer Park, Washington, is one of a number of areas in Washington State that recently received centerline rumble strips as part of a traffic safety improvement project. This stretch of two-lane roadway is an example of a rural roadway that benefits from this type of safety treatment. Crossover crashes, while rare, usually involve severe injuries and fatalities and centerline rumble strips are showing positive signs in reducing this type of crash.*

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From the Editor's Desk



*Brian Walsh, P.E.
Technical Services Manager,
WSDOT Highways &
Local Programs*

Just the other day, as I was driving on a busy freeway east of Seattle, I watched several vehicles in front of me make evasive maneuvers around debris in the number three lane (the third lane from the left shoulder). After changing lanes and passing the debris, I noticed it contained a fair amount of metal. Although mangled, the debris appeared to be a plastic chair with metal legs. I called 911 from my trusty cell phone and was connected with the Washington State Patrol dispatch. I explained to the dispatcher the approximate milepost and lane number (interestingly, WSP numbers the lanes from the right shoulder so it was the #2 lane in their book), and they said they would follow up.

The great thing about this incident is that we treat it as a routine matter, not realizing the leaps in technology that have allowed cell phone communication within developed and developing parts of the world. To show you the potential downside to any great technology, while driving on a Tacoma area freeway awhile back, I was so focused on a cell phone conversation that I did not notice cars in front of me making evasive maneuvers until it was too late. I heard the telltale thud underneath my car and saw a splintered 2 x 4 in my rearview mirror. I took the next exit to inspect my car and felt very relieved that I had escaped with no flat tires or other damage. The presence of the cell phone technology actually distracted me from my primary task, and had I not been absorbed in my conversation, I may have picked up the signs (from other drivers) that something was in the roadway. This may sound like an editorial against driving while using cell phones, but it is only one of many examples of "recent" technology where we try to sort out where it fits and where it might have to be legislatively restricted. We can't possibly predict all the issues that a new technology will raise until it is researched or tested in the field many times.

Many of our professional opinions come from experience and supporting evidence that is found in published research. Without the research and calculated risk taken through experimentation, transferring technology can have a very low chance of success. At the WST2 Center, we strive to share technology that is based on research and pilot studies that have shown a measurable degree of success. We also see successes from local agencies and share those successes with other agencies.

In this issue of the WST2 newsletter, centerline rumble strips are discussed as a new technology that is being researched extensively in an attempt to see if there are situations where this type of technology is best used. Our appreciation goes out to those state DOTs and local agencies that have experimented with the placement of rumble strips to reduce cross over type collisions (Washington State DOT data was used for the nationwide study of rumble strips).

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**Highways & Local Programs
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Michael Horton, P.E.

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Brian Walsh, P.E.

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Graphic Design
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Bob Brooks
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Any opinions, findings, conclusions or recommendations presented in this newsletter are those of the authors and do not necessarily reflect the views of WSDOT or FHWA. All references to proprietary items in this publication are not endorsements of any company or product.





By Bob Brooks, WST2 Pavement Technology Engineer, WSDOT Highways & Local Programs WST2 Center

Hot-mix asphalt (HMA) is a compound structure of aggregate particles of varying sizes, an asphalt binder to hold the mix together, and air voids. The way an HMA responds to traffic and environmental loading is dependent on the properties of these materials and the proportion or volume of each. This response to loading, then, determines the resistance of an HMA to rutting and cracking and the durability of the mix.

An HMA's compressive strength and resistance to movement under loads is primarily a function of the aggregate. The proportions and interactions between the various sized aggregate particles are often referred to as the aggregate skeleton. Aggregate skeleton performance is directly related to the hardness, shape, texture, and gradation of the aggregate. Gradation tends to be the most vague and unstructured of these properties.

Outside of the 0.45 power chart, there have been few tools available for evaluating gradation. The 0.45

Analyzing HMA Aggregate Gradations Using the Bailey Method

Derived from Transportation Research Circular Number E-C044 – Bailey Method for Gradation Selection in Hot-Mix Asphalt Mixture Design – October 2002.

power chart is limited to making changes to the gradation curve relative to the theoretical maximum density line. The Bailey Method of gradation evaluation considers the packing characteristics of aggregates. The parameters used in the Bailey Method are directly related to the voids in mineral aggregate (VMA), air voids (Va), and compaction properties. The Bailey Method offers a means to design and analyze the aggregate interlock and aggregate structure in an asphalt mixture.

The Bailey Method can be used in an HMA mix design and through the quality control effort, but it is not a mix design process. The method does not address aggregate properties like hardness, shape, and texture, nor the asphalt mix properties required to produce a quality mix.

The Bailey Method was originally developed by Mr. Robert Bailey (retired) of the Illinois Department of Transportation as a means to combat the rutting of asphalt mixes while maintaining the proper durability characteristics. It is a systematic approach to blending aggregates that provides aggregate interlock as the backbone of the structure and a balanced continuous gradation of particles to complete the blend. The method is applicable to all

dense-graded mixtures, regardless of maximum aggregate size, and can be used with any design procedure, including Superpave or Hveem. The method can also be used with stone matrix asphalt (SMA) mixes as well.

Basic Principles

In the Bailey Method, aggregate interlock is selected as a design input. The aggregate interlock provides resistance to rutting. To ensure that the mix contains adequate asphalt binder, the VMA is adjusted by changing the packing of the course and fine aggregates. This provides a strong skeleton for high stability and an adequate VMA for good durability.

These aggregate blending procedures have been validated with laboratory analysis and field trials. Illinois DOT uses it statewide and field trials are on going in the United Arab Emirates, France, Canada, as well as the United States.

Combining aggregates to optimize aggregate interlock and provide proper volumetric properties involves using the following two principles: aggregate packing and definition of course and fine aggregates. With these principles, the basic steps in the Bailey Method are: combining aggregates by volume and analyzing the combined blend.

Aggregate Packing

The degree to which aggregate particles can be packed together is dependent on the following properties:

- Type and amount of compactive energy.
- Shape of the particles: flat and elongated particles tend to resist dense packing while cubical particles tend to pack more densely.
- Surface texture of the particles: smooth textures will re-orient more easily into a dense configuration while rough surfaces resist this movement.
- Size distribution of the particles (gradation): mixed size particles pack more densely than single-sized particles.
- Strength of the particles: softer aggregates typically degrade more than strong aggregates and allow denser packing to be achieved.

These properties can be used to characterize both coarse and fine aggregates. The individual aggregate properties along with the amount of coarse and fine aggregates used in the blend determine the packing characteristics of the blend using a given amount of compaction. All of these properties should be considered when selecting aggregate sources.

Course and Fine Aggregate

A traditional definition of course aggregate is any particle that is retained by the 4.75-mm sieve. Fine aggregate is defined as any aggregate passing the 4.75-mm sieve. In the Bailey Method, the definition of course and fine aggregates is more specific in order to determine the packing and aggregate interlock. The Bailey Method definitions are:

- Coarse aggregate: Large aggregate particles that when placed in a unit volume create voids.
- Fine aggregate: Aggregate particles that can fill the voids created by the coarse aggregate.

More than a single aggregate size is needed to define coarse or fine aggregate. The definition of coarse and fine depends on the nominal maximum particle size (NMPS) of the mixture. In the Bailey Method, the sieve, which defines coarse and fine aggregate, is known as the primary control sieve (PCS) and is based on the NMPS of the aggregate blend.

$$PCS = NMPS \times 0.22$$

Where:

PCS = PCS for the overall blend.

NMPS = NMPS for the overall blend, which is one sieve larger than the first sieve that retains more than 10 percent (as defined by Superpave terminology).

The value of 0.22 used in the control sieve equation was determined from two- and three-dimensional analysis of the packing of different shaped particles. While 0.22 may not be exact for every mixture, the analysis of gradation is not affected if the value ranges between 0.18 and 0.28. The 0.22 factor is the average condition of many different packing configurations.

Combining Aggregates by Volume

In combining aggregates, you must first determine the amount and size of the voids created by the coarse aggregates and fill those voids with the appropriate amount of fine aggregate. For each of the coarse aggregates, the loose and rodded unit weights must be determined, and for each fine aggregate, the rodded unit weight must be determined.

The loose unit weight of an aggregate is the amount of aggregate that fills a unit volume without any compactive effort and represents the beginning of coarse aggregate interlock. The loose unit weight is determined using the procedure AASHTO T-19: Unit Weight and Voids in Aggregate.

The rodded unit weight of aggregate is the amount of aggregate that fills a unit volume with compactive effort applied and represents the volume of voids present when the particles are further into contact due to compactive effort. The rodded unit weight is determined using the procedure AASHTO T-19: Unit Weight and Voids in Aggregate.

The designer needs to determine the degree of coarse aggregate interlock for the mix by choosing a unit weight of coarse aggregate. In the Bailey Method, coarse-graded mixes are defined as having a coarse aggregate skeleton. Fine-graded mixes do not have enough coarse aggregate (i.e. larger than the PCS) to form a skeleton; and therefore, the load is predominantly carried by the fine aggregate. The designer must decide if the mix is to be coarse-graded or fine-graded. Theoretically, the loose unit weight is the dividing line between fine-graded and coarse-graded mixes.

If the designer chooses a coarse aggregate unit weight much less than the loose unit weight, the coarse aggregate particles are spread apart and are not in a uniform particle-to-particle contact and a fine aggregate skeleton is developed. For a fine-graded mix, the designer should choose a unit weight less than 90 percent of the loose unit weight.

The rodded unit weight is generally considered to be the upper limit of coarse aggregate interlock for a dense-graded mix. This value is typically near 110 percent of the

loose unit weight. For a dense-graded mix, the designer should choose a coarse aggregate unit weight between 95 percent and 105 percent of the loose unit weight. This will allow for some coarse aggregate interlock.

Values exceeding 105 percent should be avoided due to increased probability of aggregate degradation and increased difficulty with field compaction. Values between 90 percent and 95 percent should also be avoided because of a high probability of varying in and out of coarse aggregate interlock in the field.

Using the densities of the coarse and fine aggregates, the designer would then determine the percentages and weights of the aggregates in the blend. After determining the combined gradation by weight, the aggregate packing is analyzed further. The combined blend is divided into three distinct portions, with each portion evaluated individually.

The coarse portion of the blend is from the largest particle size to the PCS. The fine aggregate is broken down into two portions for analysis. To determine where to split the fine aggregate, the same 0.22 factor used for the entire gradation

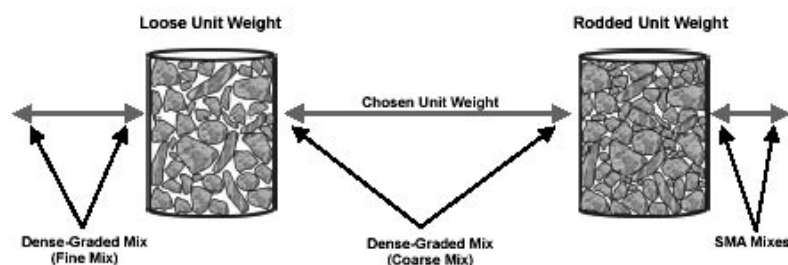


Figure 1: Selection of chosen unit weight of coarse aggregates.

Determining a Design Blend

The designer uses the following information to determine the individual aggregate percentages by weight and the combined blend:

- Bulk specific gravity of each aggregate.
- Chosen unit weight of the coarse aggregates.
- Rodded unit weight of the fine aggregates.
- Blend by volume of the coarse aggregates.
- Blend by volume of the fine aggregates.
- Amount of -0.075 mm material desired if using mineral filler or fines.

is applied to the PCS to determine a secondary control sieve (SCS). The SCS then becomes the break between coarse sand and fine sand. The fine sand is further divided by applying the same 0.22 factor to the SCS to determine the tertiary control sieve (TCS).

An analysis is then performed to evaluate packing within each of the three portions of the combined aggregate blend. Three ratios are determined: Coarse Aggregate Ratio (CA Ratio), Fine Aggregate Coarse Ratio (FA_c Ratio), and Fine Aggregate Fine Ratio (FA_f Ratio). These ratios characterize the packing of the aggregates. By changing gradation within each portion, modifications can be made to the volumetric properties, construction characteristics, and performance characteristics of the asphalt mixture.

CA Ratio

To evaluate the CA Ratio, the designer needs to consider one more sieve, the half sieve. The half sieve is defined as one-half the NMPS. Particles smaller than the half sieve are called interceptors. Interceptors are too large to fit in the voids created by the larger coarse aggregate particles and therefore spread them apart. By changing the quantity of the interceptors, it is possible to change the VMA to produce a balanced coarse aggregate structure allowing for good compaction and performance under load. The equation for the CA Ratio is:

$$\text{CA Ratio} = (\% \text{ passing half sieve} - \% \text{ passing PCS}) / (100\% - \% \text{ passing half sieve})$$

As the CA Ratio decreases below that recommended in Figure 2, compaction of the fine aggregate portion increase because there are fewer interceptors, thus requiring a stronger fine aggregate structure to meet volumetric properties. This is an indicator of a blend prone to segregation. As the CA Ratio increases beyond the recommendations in Figure 2, VMA increases but the mix becomes unbalanced because of the large number of interceptors that can lead to compaction problems in the field as the mix tends to move under the rollers.

Coarse Portion of Fine Aggregate

The equation for the FA_c Ratio is FA_c Ratio = % passing SCS / % passing PCS. As the FA_c Ratio increases beyond the recommendations in Figure 2, caused by an excessive amount of natural sand or very fine sand, the mix tends to become tender. If the FA_c Ratio falls below the recommendations, the mix tends to become gap-graded and can lead to instability and compaction problems.

**Figure 2: Recommended Ranges of Aggregate Ratios
NMPS, mm**

	37.5	25.0	19.0	12.5	9.5	4.75
CA Ratio	0.80 – 0.95	0.70 – 0.85	0.60 – 0.75	0.50 – 0.65	0.40 – 0.55	0.30 – 0.45
FA _c Ratio	0.35 – 0.50	0.35 – 0.50	0.35 – 0.50	0.35 – 0.50	0.35 – 0.50	0.35 – 0.50
FA _f Ratio	0.35 – 0.50	0.35 – 0.50	0.35 – 0.50	0.35 – 0.50	0.35 – 0.50	0.35 – 0.50

Note: FA_c Ratio = fine aggregate coarse; FA_f Ratio = fine aggregate fine. These ranges provide a starting point where no prior experience exists for a given set of aggregates. If the designer has acceptable existing designs, they should be evaluated to determine a narrower range to target for future designs.

Fine Portion of Fine Aggregate

The equation for the FA_f Ratio is $FA_f \text{ Ratio} = \% \text{ passing TCS} / \% \text{ passing SCS}$. The FA_f Ratio is used to evaluate the packing of

the smallest portion of the aggregate blend. VMA in the mix will increase with a decrease in the FA_f Ratio. This ratio indicates the volume of voids in the fine aggregate portion of the blend.

These ratios can be very useful for evaluating and adjusting VMA in the mix. Several trial blends can be evaluated on paper and the VMA increased or decreased as desired:

- CA Ratio increases = VMA increases.
- CA Ratio decreases = Segregation potential increases.
- FA Ratios increases = VMA decreases.

Changes to any of these parameters will affect the air voids, VMA, constructability, and performance of the resulting asphalt mixture. The Bailey Method can be an effective tool used to design an aggregate blend or to evaluate an existing mix design.



Putting the “Super” Back in Superpave: Increasing Durability in Superpave Mixes

Reprinted by the permission of the National Asphalt Pavement Association from their magazine, Hot Mix Asphalt Technology, January/February 2004, copyright 2004. Written by Don Christensen and Allen Cooley.

From 1987 to 1993, the Strategic Highway Research Program spent approximately \$50 million on research to develop new methods for specifying and designing hot mix asphalt (HMA). The result of this large research effort was a new mix design system called Superpave (Superior Performing Pavements). Superpave includes requirements for aggregates, asphalt binders, and the compacted mixture. These checks and balances were included within the Superpave mix design system to help ensure that the resulting pavements would be both rut resistant and durable.

A recent review of the performance of Superpave designed mixes conducted by the National Center for Asphalt Technology (NCAT) showed that they provide good resistance to rutting. However, the review also indicated that there was a potential durability problem with some Superpave mixtures.

The purpose of this article is to discuss mixture characteristics and construction practices that can affect Superpave durability.

A durable pavement will provide a smooth, safe ride to the public with minimal maintenance and repair over its design life. This means that it must not only stand up to the pounding of millions of vehicles, but also must resist the damaging effects of sunlight, air and water on the engineering properties of the pavement.

Fatigue Damage

Pavement engineers estimate the amount of traffic on a road using equivalent single axle loads (ESALs), which represents the number of 18,000 lb truck axles that would cause damage equivalent to that resulting from the number and types of vehicles expected on a pavement during a given time period. Typical

pavements might be subjected to anywhere from 100,000 to 10 million ESALs or more over a design life of 20 years, depending on the type of road, traffic patterns, and population density.

Fatigue damage occurs when tiny cracks gradually grow larger and more numerous under the effect of traffic loading. Fatigue damage will be most severe where the stresses and strains are the largest—generally at the underside of the bottom lift of asphalt-- and to a lesser extent, at the pavement's surface. At first, fatigue damage will accumulate without any visible signs of distress. Eventually, small cracks will become visible in or near the wheel paths (Figure 1).

Once fatigue cracks become visible, they will often grow in number and size very rapidly, until the pavement fails completely. Besides being unsightly and creating a rougher ride for the traveling public, fatigue cracks allow air and water to penetrate the pavement, causing additional damage to the asphalt.

Age Hardening

Oil burns very easily and is a good fuel because it is made up mostly of carbon and hydrogen, which react readily with oxygen to given [sic] off carbon dioxide, water and heat. Asphalt cement is produced from crude oil, and also reacts with oxygen, though very slowly. The results of this oxidation in a roadway are all too easily noticed—the asphalt cement binder, and the pavement that it holds together, slowly become harder and more brittle. As the pavement becomes more brittle it becomes more prone to fatigue cracking and has increased potential for raveling. Another cause of age hardening is the gradual evaporation of light oils from the asphalt binder. Age hardening and traffic loading can work together to cause premature cracking in asphalt concrete pavements.

Effects of Traffic Level and Weather

Environmental factors affecting durability of asphalt concrete pavements include temperature, amount and intensity of sunlight,

and precipitation. High temperatures and increased exposure to sunlight will increase the amount of age hardening in a pavement, especially at the pavement surface.

Moisture damage occurs when water from rain or melting ice and snow gradually destroys the bond between the asphalt cement binder and aggregate in a pavement. Once a substantial amount of asphalt binder is stripped away from the aggregate, the asphalt concrete will be severely weakened and will rapidly disintegrate under traffic loading. Fatigue damage and moisture damage often occur together, with disastrous results. Fatigue damage creates micro-cracks and voids that provide water access to the asphalt-aggregate bond. This moisture damage weakens the pavement, allowing fatigue damage to occur even more rapidly.

In order to increase market share of asphalt concrete pavements, road builders must provide the public with a durable pavement at a reasonable cost, a challenging task for technicians responsible for mix design and construction.

Developing Better Mix Designs

The objective of any mix design process is to combine the asphalt binder and aggregates in such a way that the resulting asphalt concrete will have resistance to rutting, fatigue cracking, age hardening and moisture damage. Most durability problems—and rutting problems—occur at or near the surface of the pavement, so the comments here for the most part apply to the design of wearing course mixtures.

Recent research has confirmed findings made over the past 30 years that asphalt concrete mixtures resist fatigue with a higher asphalt binder content.

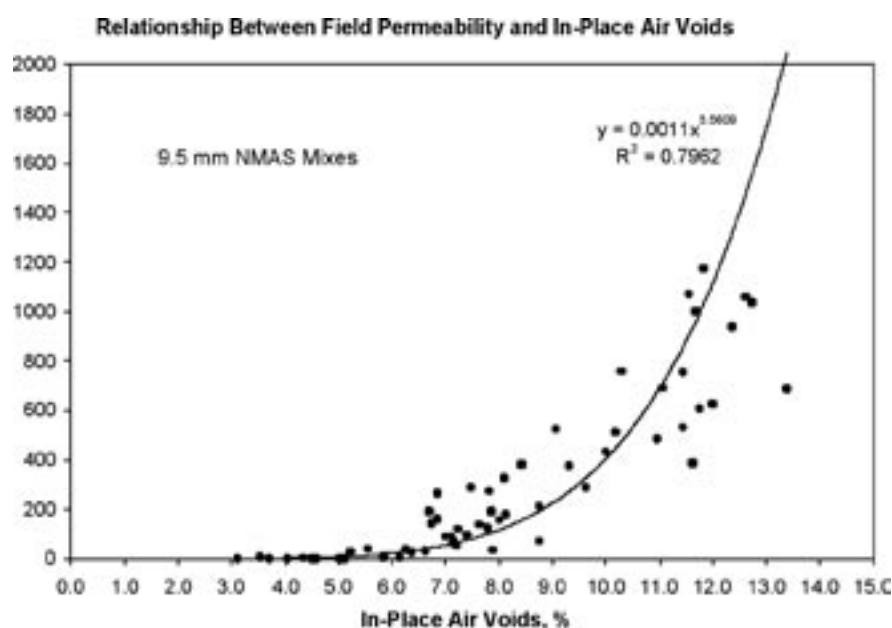


Figure 1

Therefore, durable mix designs should have a reasonably high binder content. Higher binder contents have also been shown to reduce the potential for moisture damage.

High binder contents also lead to an increased potential for rutting. Therefore, mix designers must provide a reasonably high binder content while maintaining good rut resistance. This can be achieved by taking the following steps in developing wearing course mix designs:

- Avoid using large-size aggregate gradations—use 12.5-mm nominal maximum aggregate size (NMAS) or smaller;
- Keep the mineral filler content at a level that will provide good all-round performance;
- Select the correct binder grade for a given application.

For extreme applications requiring binders two or three high temperature grades above the standard for the local climate, pavement designers should use a binder modified with SB or SBS polymer, or some other polymer modifier of proven performance. Conventional asphalt binders with very high viscosities potentially contribute to early fatigue failures because their poor flow properties at high temperatures can inhibit healing of minor cracks during hot weather. Asphalt binders properly modified with elastomeric polymers do not exhibit this problem, since the base asphalt usually has a fairly low viscosity and will thus maintain good healing characteristics.

Besides minimizing the amount of fatigue damage occurring in a pavement, using mixtures with relatively small aggregate sizes rich in asphalt binder will also be more resistant to age hardening and moisture damage. This is because air and water will flow much more slowly through a

paving mixture made with a fine aggregate gradation and with a high ratio of voids filled with asphalt (VFA), and/or low air void content. This principle was demonstrated in a research project conducted at NCAT to evaluate the permeability characteristic of Superpave designed mixes. This is one of the reasons it is important to properly compact a pavement during construction. Otherwise, the pavement surface will allow air and water to penetrate its surface and will simply not last as long as it should under the effects of traffic loading, sunlight, air and water.

Relationship Between Permeability and Pavement Density

In the past, the Superpave system placed much emphasis on the “restricted zone” in aggregate gradations. The restricted zone corresponded to a maximum density gradation in the region of fine-sand particle size—from about 0.150 to 2.36 mm (No. 100 to No. 16 sieve size). Superpave aggregate gradations normally were to avoid this restricted zone, either by passing above it (a “fine” gradation) or passing below it (a “coarse” gradation). It was believed that aggregate gradations that passed through this restricted zone would exhibit poor rut resistance and/or tenderness during compaction. Recent research has shown that with the quality of aggregates now being used in HMA, there is no need to avoid the restricted zone. Good rut resistance and compaction characteristics can be achieved regardless of whether a mix is fine, coarse or dense.

Although the Superpave system includes limits, or “control points” for aggregate gradations, current specifications do not provide any guidelines for determining the optimum aggregate blend for achieving good performance. One approach to determining effective aggregate blends that has recently

gained some attention is the Bailey method, originally developed by Robert Bailey, a retired engineer for the Illinois DOT. This somewhat complicated procedure considers the packing characteristics of each aggregate, and the type and degree of interlock achieved by blending the aggregates in different proportions. According to its proponents, the Bailey method provides the strong aggregate structure needed for rut resistance, along with the reasonably high VMA required for durability. The Bailey method is described in detail in Transportation Research Circular No. E-C044, available from the Transportation Research Board, 500 5th Street, NW, Washington, DC 20001.

Importance of Good Construction Practices

There are two primary issues that must be closely controlled during construction to help alleviate durability problems. First, segregation of the mix, both physical and thermal, should be minimized. Physical segregation is the separation of the individual mix constituents, while thermal segregation is the occurrence of non-uniform temperatures within a placed mat. Numerous studies have shown that segregation can reduce the anticipated life of a pavement through cracking, moisture damage, and/or raveling. Using equipment that re-mixes the HMA prior to charging the paver hopper helps to minimize both physical and thermal segregation.

Another major construction issue related to durability is the proper compaction of the mix on the roadway. Compaction should be conducted in such a way that the mixture reaches the desired density and the aggregates within the mix are not excessively fractured. Initial in-place air void contents should not be below 3 percent or above 8 percent. Low in-place air voids have been shown

to result in rutting, bleeding, and shoving. High air voids lead to permeability problems such as moisture damage or excessive oxidation of the asphalt binder, which can accelerate fatigue cracking and pavement failure.

As mentioned previously, both pavement density and aggregate size affect permeability of HMA layers. Another factor that can influence permeability is lift thickness. By increasing the lift thickness, pavement designers can achieve a better density and, hence, lower permeability. Larger lifts allow more room for aggregate particles to orient themselves in a manner that higher densities can be achieved. Also, thicker lifts mean more volume of mix is placed which allows the mix to maintain compaction temperature longer than thinner lifts.

Asphalt concrete mixtures designed using the Superpave system have in general exhibited excellent rut resistance, but in a few cases have shown a tendency to ravel and crack after only a few years. Mixtures with both rut resistance and durability can be produced with a few modifications and extra care in construction.



Don Christensen is senior engineer, Advanced Asphalt Technologies. Allen Cooley is senior construction materials engineer, Burns Cooley Dennis.

- Avoid using aggregate gradations larger than 12.5 mm NMAS for wearing course mixtures.
- For good fatigue resistance, mixtures should contain at least 11 percent effective asphalt binder by volume.
- To maintain good rut resistance, make certain that asphalt binder / mineral filler ratios are kept within the range consistent with good all-around mixture performance with the selected materials.
- Avoid physical and thermal segregation of mixtures during transport and placement.
- Compact mixtures to an in-place air void content of about 3 to 8 percent.
- Avoid thin lifts during construction, since thicker lifts will usually be easier to compact properly.

Can You Fill Forms Without Vibrating?

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Self-consolidating concrete is used for both its flowability and durability—and for its incredible ease of use.

By M. K. Hurd

A concrete that places itself? Self-consolidating concrete (SCC), or self-compacting concrete, as some prefer to call it, comes close to doing just that. Well-proportioned SCC can flow under its own weight through and around congested reinforcement, filling forms completely and producing a void-free mass with little or no mechanical vibration. Don't

confuse it with the other "flowing" concretes that are subject to segregation problems and require vibration to achieve compaction.

SCC development began in Japan in the early 1980s because of concerns about concrete durability, with researchers realizing that poor consolidation of concrete was a major factor in the declining quality of construction work (Ref. 1). Available know-how on controlled-segregation mixes designed for underwater placement could not be directly adapted to structures in air, and it was not until 1988 that K. Ozawa demonstrated the first true SCC mix. Subsequent study by major

Japanese contractors who developed their own in-house systems improved the mixes and fostered the widespread use of SCC in Japan today.

The commercial success of SCC in Japan is underscored by a government-supported plan that has seen SCC usage exceed 50 percent of all concrete placed there today. This technology was transferred to Europe during the 1990s with the development of the polycarboxylate generation of high-range water reducers (superplasticizers). Substantial progress has been made there, particularly in Sweden, France, and the United Kingdom (U.K.). The Concrete



SCC delivery in Toronto for bottom-up pumping of 101-foot-high steel-form, steel-reinforced columns that were only 28 inches in diameter.

Society (U.K.) has issued a Current Practice Sheet on SCC as part of its ongoing effort to further the use of SCC in general construction.

Now SCC technology is available in North America in the form of proprietary concrete mixes

offered by ready-mix producer subsidiaries of cement manufacturers such as Lafarge and Lehigh, or as specialized admixtures, frequently a combination of polycarboxylates and viscosity modifiers. Although the admixtures needed to produce SCC are available from a number of suppliers, most of the U.S. experience to date has been in precast concrete plants. Typically an admixture company's technical service staff can work with the precaster to develop a suitable mix. Nitterhouse Concrete Products in Chambersburg, Pa., is a case in point. According to Glynn Kindelan, vice president for production, Nitterhouse has been using an admixture

developed by Sika Corp. for its structural precast products. He is enthusiastic about improved productivity with SCC. Using only portland cement and no pozzolans, Kindelan reports "incredible strengths" upward of a 50 percent

increase in overnight breaks, enabling substantial reductions, or elimination of heat for curing in addition to early stripping.

Gary Knight, senior technical services engineer for Grace Construction Products, says that for SCC to be successful in ready-mix operations a higher standard of quality control is required, particularly regarding the amount of water. Because of the limited cast-in-place applications in United States, some of the general information that follows is based on European practices.

Proportioning SCC

Materials: The new generation of superplasticizers—based on polycarboxylated ethers—has been an important factor in making SCC a practical reality. Normal concrete aggregates are generally suitable for SCC, but the grading will probably be different. Portland cement and other fines, including ground limestone fines, fly ash, and ground granulated blast furnace slag, may be needed in larger



Left: Slump flow test. A technician lifts the slump cone and measures the diameter of SCC spread.



Right: The L-box test measures flow and blocking resistance of the SCC mix.

proportions than in conventional concrete to obtain the desired cohesion. Specialized admixtures that control flow characteristics, workability retention, and viscosity or cohesion of the mix are crucial to SCC performance. Air-entraining admixtures are also used where necessary.

Mix design objectives: A specific mix design must be based on the intended application, suited to anticipated congestion of reinforcement or complexity of the form. Typically there will be less coarse aggregate and a proportionally larger amount of fines including portland cement, fly ash, ground slag, and stone powder. Broadly speaking, the fresh SCC must be able to flow into all the spaces within the formwork under its own weight. It must also flow through narrow openings such as the spaces between reinforcing bars—a constraint that may limit the maximum aggregate size. While maintaining this flow, it must also resist segregation. Meeting all of these demands results in mix proportions that differ from conventional concrete, as Table 1 shows.

Cost vs. Benefit

Although SCC will generally cost a few more dollars per cubic yard than a conventional 6-inch-slump

concrete, the in-place cost of the concrete will actually decrease because of such factors as:

- Reduced construction time;
- Reduced manpower for placing and compacting;
- Lower equipment costs and reduced noise since vibrators are not required;
- Ability to fill complex forms and members with congested reinforcement; and
- Elimination of rubbing and patching ordinarily required to fill defects in poorly consolidated surfaces.

The principal benefits of SCC are the characteristics of the fresh mix, but reconciling easy flow, on the one hand, with increased cohesion and resistance to segregation on the other, places particular demands on the mix design.

On the debit side, some SCC mixes may gain strength more slowly because of higher proportions of fly ash, silica fume, or ground slag. Because of the high fines content and viscosity of SCC, it exhibits little or no bleeding. This slows evaporation and reduces total plastic settlement. The water that does evaporate, however, is not replaced by bleed water, and so

there is a potential for increased plastic shrinkage cracking. Therefore attention to curing is important, particularly on large, flat exposed areas.

Hardened SCC, as compared with traditional vibrated concrete of similar water/cement ratio, is expected to have:

- The same structural behavior;
- Equal or higher tensile and compressive strength;
- Equal or lower drying shrinkage;
- Equal or better bond to reinforcement;
- Lower surface absorption and therefore better durability; and
- Freeze/thaw resistance similar to conventional concrete when non-air-entrained; equal or better when air-entrained mixes are compared.

North American Standards Needed

Is all self-consolidating concrete the same? Joseph A. Daczko, manager of concrete technology and materials testing laboratories at Master Builders in Cleveland and chairman of ACI's newly formed Committee 237, "Self-Consolidating Concrete," answers with a resounding "No!" A whole spectrum of mixes can be described as self-consolidating, and this is a major reason why standards are needed.

Ken B. Rear, manager of concrete research and support at Heidelberg Technology in Atlanta agrees. "One of the things we need right now is a definition," says Rear. "The product is in its infancy in North America." He says that a standard definition has been worked out between the American Concrete Institute (ACI) and the American Society

Table 1—Volume comparison of materials in typical SCC and conventional concretes*

Material	Traditional concrete, by volume	SCC, by volume
Admixtures	trace	0.01%
Water	18%	20%
Coarse aggregate	46%	28%
Sand	24%	34%
Fines, including portland cement	12%	18%

*Based on information provided by Gaimster and Gibbs in Reference 2.

for Testing and Materials (ASTM). ASTM subcommittee C09.47, Self-Consolidating Concrete, is currently balloting a definition consistent with ACI's definition: "A concrete that can flow around reinforcement and consolidate within formwork under its own weight without additional effort, while retaining its homogeneity."

Three properties of the fluid concrete are important and are being tested, albeit with test methods that have yet to gain standard status. The properties are flowability, resistance to segregation, and ability to pass through tight spaces. Flowability is normally tested with the slump flow test. A slump cone is filled, sometimes inverted to make filling easier, and then lifted, and the diameter of the resulting flattened concrete is measured, indicating the self-leveling characteristic of the mixture. SCC flow typically reaches a spread diameter of 24 to 32 inches on a specially marked board. Another measure that can be determined with this test is the T-50 value, which is a measure of the time it takes for the spreading concrete to reach the 20-inch (50-cm) ring.

Tests used to assess the concrete's ability to pass through tight spaces include the L-box, U-box, J-ring, and V-funnel. ASTM Subcommittee C09.47 is finalizing test methods for the J-ring and the L-box. The L-box has a sliding door separating the vertical and horizontal portions of the L-shaped form. When the door is raised, concrete flows under its own weight into the horizontal section, passing through reinforcing bar obstacles. This test measures the ability of a mix to flow through restricted spaces.

Resistance to segregation is usually evaluated with the Visual Stability Index (VSI). The VSI is a qualitative test that compares photographs and descriptions of mixes with various degrees of segregation and bleeding. A draft standard for the VSI has been developed within ASTM but is still being worked on. Another test for this property that is currently moving through ASTM is the column segregation test.

Future Development

This is still an emerging technology, one that has been accepted by a number of precast producers, but has seen only limited cast-in-place applications in North America. Early applications have been on special projects with difficult access or highly congested reinforcement, such as the Toronto International Airport's 101-foot-tall steel-form columns pumped from the bottom. Another, more common application, is the trial conducted on Habitat for Humanity houses in Houston.

In November 2002, the Center for Advanced Cement-Based Materials at Northwestern University sponsored the First North American Conference on SCC—an exciting event that drew a crowd of nearly 300 from around the world (Ref. 5) and reported on a technology that is moving forward in leaps and bounds. Still, much work remains to be done on specifications and standardized tests to assess the fresh concrete properties. Guidance on formwork pressure effects is needed. The Strategic Development Council of the ACI Concrete Research and Education Foundation also has a consortium on SCC, which along with several formwork manufacturers is investigating that problem. Long-term

evaluation of shrinkage, creep, and elastic modulus will have to be made. Until these information gaps are filled, projects will proceed on a case-by-case basis with trial mixes prepared for specific jobs. PW

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▲
— Hurd, a civil engineer and writer specializing in concrete construction, is former editor of *Concrete Construction* magazine. She is also author of *Formwork for Concrete*, the American Concrete Institute's SP-4 manual, now in its sixth edition.

Center Line Rumble Strips Reduce Crash Risk on Rural Two-Lane Roads

*Reprinted by permission from
Utah LTAP On the Move Quarterly
Newsletter, Winter (January) 2004,
Volume 17, Number 1. Written by
Richard Retting, Insurance Institute for Highway Safety*

On a national basis, rural roads account for approximately 40 percent of all motor vehicle travel but 60 percent of all fatal crashes. Approximately 90 percent of all fatal crashes in rural areas occur on two-lane roads, which typically lack physical measures such as wide medians or barriers to separate opposing traffic flows.

As a result, a major crash problem on these roads involves vehicles crossing the centerline and either sideswiping or striking opposing vehicles head-on. These types of opposing-direction crashes account for about 20 percent of all fatal crashes on rural two-lane roads and result in approximately 4,500 fatalities annually.

The risk of head-on and opposing-direction sideswipe crashes can be reduced by engineering improvements such as roadway widening and median barrier installation. However, such measures are costly and therefore generally are applied on a limited basis to high-priority locations.

Because centerline incursions can occur at virtually any point along undivided roads, spot safety improvements can provide only limited protection against widespread opposing-direction crashes. More widely applied measures are needed to reduce the risk of drivers inadvertently crossing roadway centerlines.

One such potential countermeasure entails installation of rumble strips along the centerlines of undivided rural two-lane roads to warn/alert distracted, fatigued, or speeding motorists whose vehicles are about to cross the centerlines and encroach into opposing traffic lanes.

A comprehensive before-and-after study was undertaken to estimate the nature and magnitude of crash reductions associated with installation of center line rumble strips on rural undivided two-lane roads. Data were drawn from seven states: California, Colorado, Delaware, Maryland, Minnesota, Oregon, and Washington. In total, 98 treatment sites along approximately 210 miles of road were studied. Statistical procedures were used to properly account for regression to the mean--a threat to the validity of simple before-and-after studies--while normalizing for differences in traffic volume and other factors between the before and after periods.

Overall, motor vehicle crashes at treated sites were reduced 14 percent; injury crashes were reduced by an estimated 15 percent. Head-on and opposing-direction sideswipe crashes--the primary target of center line rumble strips--were reduced by an estimated 21 percent, while head-on and opposing-direction sideswipe crashes involving injuries were reduced by an estimated 25 percent.

This result, taken together with the fact that installation costs are relatively low, suggest that consideration should be given to wider application of center line rumble strips on rural two-lane roads to reduce injury crashes.

For a free copy of the full report, contact publications@iihs.org.



To Salt Or Not To Salt? – That Is The Question

By Bob Brooks, WST2 Pavement Technology Engineer, WSDOT Highways & Local Programs WST2 Center. Derived from Washington State Department of Transportation 2002-03 Salt Pilot Project – August 2003 by Enrico V. Baroga)

The 2003–2004 winter season finds the Washington State Department of Transportation (WSDOT) in its second season of evaluation and trying to answer the question, to salt or not to salt. The Salt Pilot Project, begun in the winter of 2002–2003 and carried over through this winter season, attempts to make an empirical, in-field comparison of the use, effectiveness, and impact of sodium chloride to corrosion-inhibited snow and ice control chemicals. The evaluation of these products is focused on four areas: cost of program delivery, program results, environmental impacts, and corrosion potential.

Until the late 1980s, WSDOT used sodium chloride (rock salt) for snow and ice control activities. Rock salt was used on the roadways to help melt snow and ice. It was also used on sand stockpiles

to prevent them from freezing and to keep them workable. After this time frame, anti-icing practices were widely used, and WSDOT moved to the use of corrosion-inhibited snow and ice control chemicals such as magnesium chloride, calcium chloride, and calcium magnesium acetate. These chemicals promised a broader temperature range for better snow and ice control and less corrosion to metal.

The objectives of the Salt Pilot Project are to compare sodium chloride to corrosion-inhibited snow and ice control chemicals under real-world conditions to determine cost of use, effectiveness, corrosion potential, and environmental concerns due to chloride level build-up. Two test sections on I-90 were selected where rock salt and salt brine would be the only snow and ice control chemicals used. Two additional control sections on I-90 were also selected where corrosion-inhibited chemicals would be used exclusively. All four sites are located in Eastern Washington between the I-82 Interchange and the Idaho border. An additional

salt brine test section was later added in Western Washington on SR 6 between I-5 and SR 101.

Both the I-90 salt test sections utilized salt brine as the liquid

anti-icing chemical. The brine was made by mixing rock salt with water to a concentration of 23 percent sodium chloride. This concentration is considered optimal for anti-icing. A Varitech SB600 salt brine maker was purchased and used to make the brine. The same rock salt used to make the brine was also used directly on the roadway when conditions warranted. The brine used on the SR 6 test section was made by mixing rock salt with water in a storage tank. No rock salt was used directly on the SR 6 test section.

The I-90 control sections used liquid calcium chloride, liquid magnesium chloride, and corrosion-inhibited rock salt. On both the I-90 salt test sections and the I-90 control sections, liquid chemicals were applied using herbicide spray trucks or modified tank trucks. Solid chemicals were applied by dump trucks fitted with hopper/sander units. The SR 6 section was somewhat different in that brine application was focused on emphasis areas (curves, steep grades, intersections).

Cost

Snow and ice control costs incurred within each of the test and control sections were tracked to allow for a comparison of the operational costs. Labor, equipment, and material costs were tracked. Project preparation costs, the construction of salt storage sheds, and purchase of the brine maker were not included in the calculations. The cost of producing the salt brine was factored into the material costs.



The table below shows a breakout of the total labor, equipment, and material costs for the salt sections and the corrosion-inhibited chemical sections during 2002-03.

As can be seen from Figure 2, the overall cost for the I-90 salt sections was considerably less than the corrosion-inhibited chemical sections. The salt sections at \$507 dollars/ lane mile were 56% less than the corrosion-inhibited chemical sections.

Location	Labor	Equipment	Materials	Lane Miles	\$/Ln Mile
I-90 Chem. Sec's	\$65,839	\$31,518	\$404,171	432	\$1,161
I-90 Salt Sec's	\$40,557	\$18,617	\$120,864	355	\$507
Difference	\$25,282	\$12,901	\$283,307	77	\$654
Location	Labor	Equipment	Materials	Lane Miles	\$/Ln Mile
SR 6 Salt Sec	\$4,042	\$1,784	\$5,914	103	\$114

Figure 2: Salt Pilot Project Costs

Performance

Several evaluations were conducted throughout the winter season to determine a Level of Service on all of the pilot project sections. Service levels run from "A", the highest, to "F", the lowest. All the I-90 sections, both salt and chemical, had a Level of Service in the "A" range. The SR 6 salt section also rated an "A" Level of Service. All sections enjoyed a high Level of Service through the winter season due in part to the mild weather experienced during the 2002-03 season.

The salt brine performed comparably to the corrosion-inhibited chemicals in its ability to prevent frost from forming and to prevent snow and ice from bonding to the pavement surface. It should be pointed out, however, that salt brine requires a temperature of approximately 20 degrees F or warmer to accomplish this. Colder temperatures degrade the performance of the salt brine and allow the corrosion-inhibited chemicals, which work at lower tempera-

tures, to perform better. The salt brine retained its effectiveness for approximately one day less than the corrosion-inhibited chemicals.

The overall impression of maintenance crews was that salt brine offered better handling and working characteristics than the corrosion-inhibited chemicals and would remain in solution without agitation.

Corrosion

One attraction to the corrosion-inhibited chemicals is that they are claimed to be 70% less corrosive than salt on metal surfaces. Field tests were conducted to determine if this was true under real world conditions. Plates of mild steel, sheet aluminum alloy, and cast aluminum alloy were placed on vehicles used within the test sections and mounted on guardrail posts within the sections. Metal plates were also mounted outside of the sections as a control.

After the winter season, the plates were collected, processed, and weighted to determine corrosion loss. The results were somewhat surprising and ambiguous. The location of the plates and metal type affected the amount of corrosion that was experienced. In general, steel plates experienced more corrosion with salt than with corrosion-inhibited chemicals. However, steel plates mounted closest to the road on guardrail posts showed the opposite effect. Sheet aluminum showed more

corrosion with the corrosion-inhibited chemicals than with salt in nearly every instance. The cast aluminum plates showed more mixed results with some favoring salt and others the corrosion-inhibited chemicals.

At no time, however, did the corrosion-inhibited chemicals provide anywhere near the claimed 70% reduction in corrosion. One has to wonder how much corrosion benefit is actually gained from corrosion-inhibited chemicals, especially considering the dramatic cost differential.

Environmental

Field sampling and lab tests were conducted to determine the amount of chloride residue in the roadside environment both before and after the 2002-2003 winter season. Samples were taken at the roadside, 10 feet from the roadside, from ditch sediment and/or a pond, if present, and from drinking water obtained at rest areas within the project area.

Total chlorides showed little significant change from pre-winter to post-winter sampling at the roadside and 10-foot locations. There was a small increase in chlorides in the salt sections in the ditch sediment after post-winter sampling.

Water samples showed little change from pre-winter to post-winter testing. There was a very slight increase in chloride levels in drinking water in the salt sections.

None of the testing revealed any concerns with chloride levels in any of the locations and all were below state and federal standards and guidelines.

Given the results of the first winter's field tests, it would appear that corrosion-inhibited chemicals are not living up to the claims made for them. They seem to provide very limited benefits while running up snow and ice control costs significantly. ▲

The Washington State Technology Transfer Center Announces the 2003 Crystal Mouse Award Winner!

By Larry Schofield, WST2 Technology Transfer Engineer, WSDOT Highways & Local Programs WST2 Center

The Washington State Department of Transportation's WST2 Center announces the winner of the 2003 Crystal Mouse Award. Each year, the WST2 Advisory Committee selects the best idea published in the WST2 newsletter. The selection was based on the following five criteria:

1. Safety
2. Cost Savings
3. Inventiveness
4. Transportability
5. Effectiveness

The committee voted WSDOT's Shelton Maintenance team's Asphalt Patching Grader Attachment as the best mousetrap published in the WST2 during the year 2003. Tim Van Berkomp invented the Asphalt Patching Grader Attachment with help from co-workers Aaron Corliss and Eric Hembury. Congratulations to the winners for their creativeness in developing a tool to improve cost savings, productivity, and, above all, safety of the crew.

This unique invention is used for patching trenches, potholes, and ruts. Two "boots" or blades are attached to a road grader's mold-board blade. The boots are width adjustable for patching and can also be rotated out of the way for full blade width asphalt patching.

Tim had help from co-workers to build the apparatus. The first version was constructed in 1995. Since then, the grader blade attachment has changed little in design. The last modifications were done in 1996.

Total cost to build the Asphalt Patching Grader Attachment was about \$500 with most of the material obtained from the scrap pile. The only item purchased was the pipe that the attachment blades slide back and forth on to adjust for patching width.

The greatest savings are in reducing the potential for back injuries from raking asphalt all day long and in lower labor costs. The crew size needed for this type of operation has been reduced from 5 or 6 people to 3 people. Minimal raking and shoveling of asphalt is now required.

Other benefits include smoother patches and a more efficient operation. The ACP grinder, rented from the City of Bremerton to prepare the potholes, costs about \$700 a day. The old way of doing business meant the crew would spend up to two hours preparing the potholes using the grinder and then fill



Tim Van Berkomp with the Asphalt Patching Grader Attachment.

them with ACP. Using the grader attachment, the grinding operation is three times faster. The attachment saves approximately \$1,400 a day and uses approximately 120 tons of ACP.

"The best thing about this invention is the reduced potential for back injuries that could end up being a life-long disability. And it does improve the quality of the job and increases production too," said Larry Deemer, WSDOT Maintenance Supervisor.

Your Mousetrap Could Be a Winner

If you have not submitted your mousetrap for publication, please do so. It helps us get the word out so others can reap the benefits of your invention and gives us a chance to acknowledge you and your ideas.

There are two ways to submit your mousetrap for publication:

1. Fill out the mousetrap registration form enclosed in this newsletter and include as many photos or digital photos as possible (please include photos of the inventors and fabricators too) along with sketches and dimensions, then mail them to us at:

Build a Better Mousetrap
WST2 Center-WSDOT
PO Box 47390
Olympia, WA 98504-7390

2. Fill out the mousetrap registration form online at: <http://fmapps.wsdot.wa.gov/mousetraps/Register.htm>

This link can also be used to register the mousetrap for exhibition at the 2004 Pacific Northwest Technology Transfer Expo to be held May 18-19, 2004, in Moses Lake, Washington. Just check the box located on the online form.



Retired Professionals: Ready to Work for You

Need help with a special project? Need the skills and experience of a public works professional? The WST2 Center's database of Retired Professionals may be just what you need. It is a skills bank of professionals with expertise in maintenance, operations, engineering, inspection, construction, and surveying, just to name a few. You can browse through the listings from the T2 home page:

<http://www.wsdot.wa.gov/TA/T2Center/T2hp.htm>
Click on Retired Professional Program

We would like to increase the awareness of this program. We encourage you to tell your staff and soon-to-be-retired employees about this program. We would like to see this skills bank grow and become a strong, extensive, and useful resource for agencies when there is a need for outside professional help.

Are you retiring soon? Want to continue with part time, full time, or occasional employment? You can now enter your resume directly online by going to:

http://fmapps.wsdot.wa.gov/retired_professional_reviewer

Enter all of your information and give yourself a Retiree Identifier that will allow you, and only you, to return at another time to make changes to your record. Then, click the register button. A window will pop up asking for a User ID and Password. You should enter:

User ID: retired

Password: kindof

This will be the only time you enter the User ID and Password.

Your resume will be sent to Laurel Gray for review and posting to the web. If you prefer, you can access the first web site above for a hard copy of the form to send to the WST2 Center.

If you have questions, contact Laurel Gray at (360) 705-7355 or GrayL@wsdot.wa.gov.

Mousetrap Registration

Name of Invention: _____

Agency: _____ (WSDOT) Region: _____

Mailing Address: _____

City: _____ State _____ Zip+4: _____

Contact Person: _____

E-mail Address: _____

Phone: () _____ Fax: () _____

Inventor(s)/Fabricator(s): _____

E-mail Address: _____

Phone: () _____ Fax: () _____

Supervisor's Name: _____

What prompted this invention (or equipment modification)?

How was it developed?

Labor, Equipment, Materials Used (from scrap pile? Did you purchase any parts?:

Cost Estimate (a rough guess will do):

Benefits to your operations:

Include sketches or plans of your "Better Mousetrap" with dimensions and materials identified, and photographs of the item from all angles (front, top, side, etc.) with the inventors if possible, to:

Build a Better Mousetrap
WSDOT-WST2 Center
PO Box 47390
Olympia, WA 98504-7390

For more information and photos of Mousetraps and Expo, check the Washington State T2 Center's web page:
www.wsdot.wa.gov/TA/T2Center/t2hp.htm
or contact Wendy Schmidt at (360) 705-7386 for details.

You can now register your Mousetrap online at: <http://fmapps.wsdot.wa.gov:590/mousetraps/Register.htm>



Matthew Enders, Local Traffic Services Branch Manager, WSDOT Highways & Local Programs (H&LP)

New Local Traffic Services Branch Manager

Matthew Enders has been appointed as Washington State Department of Transportation (WSDOT) Highways & Local Programs (H&LP) Local Traffic Services Branch Manager. Matthew brings a wealth of traffic engineering experience to H&LP, including work with a number of local agencies. Having served most recently as WSDOT's Corridor Safety Program Manager and as Traffic Analysis Engineer in the WSDOT Headquarters Traffic Office before that time, Matthew is well versed on operational and safety issues that affect roadways and in recommending realistic improvements that work. In addition to managing a statewide program, he is also a member of the Collision Data committee that will be updating the Collision Report Form in 2004. The form is used by WSP and all local police agencies.

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Washington State Technology Transfer Center (WST2) Retreat

By Brian Walsh, P.E., Technical Services Manager, WSDOT Highways & Local Programs

During February of this year, the WST2 Advisory Committee met with the WSDOT Highways & Local Programs (H&LP) staff responsible for directing the WST2 Center at a retreat style gathering. The goal of the retreat was to assess how the WST2 Center was delivering its programs, the successes, and "what could be added or improved" for the Technology Transfer program. A "visioning" process was done to gather as much information and ideas as possible to find out what the priorities would be for the next three or four years. A trained facilitator worked through a number of issues with the group including: the technology newsletter, training, outreach, and how to deliver technology within the available resources (budget, staff, and expertise). H&LP, the WST2 Center,

and the Advisory Committee have all added new leadership in recent months and this retreat style meeting offered a chance to build new relationships, a necessary ingredient to deliver a successful program. Members of both the Advisory Committee and the WST2 Center bounced ideas around, including the new and "recycled" ideas that may work with the new combinations of expertise available. People and partnerships will continue to shape the direction of H&LP and the WST2 Center as they have in the past, and the meeting outcomes (many that will be implemented this year) have given the WST2 Center motivation and direction for the next several years. Quarterly meetings with the WST2 Advisory Committee will help refine the direction. The WST2 Advisory Committee is made up representatives from various local agencies, state agencies that represent local interests, tribal lands, and federal agencies.


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What is National Public Works Week (NPWW)?

It's a celebration of the tens of thousands of men and women in North America who provide and maintain the infrastructure and services collectively known as public works.

Instituted as a public education campaign by the American Public Works Association (APWA) in 1960, NPWW calls attention to the importance of public works in community life. The week seeks to enhance the prestige of the often-unsung heroes of our society—the professionals who serve the public good every day with quiet dedication.

APWA encourages you to take the opportunity to make your stories known in your communities.



To Help You Celebrate, APWA Offers Several Resources:



2004 National Public Works Week Poster

This year's National Public Works Week Poster is done by award-winning artist Bud Peen. The art focuses on the pervasiveness of public works. The community depends on the men and women that are always there and always ready. This idea is reflected in the theme "24/7: Focused on Our Community."

At the NPWW Website: www.apwa.net/npww

- **NPWW How-To Guide-** learn how to create proclamations and solicit endorsements from government officials, write articles and press releases, and generate speeches. There are also several suggestions for celebratory activities.
- **Tell Us About Your Outreach-** you can submit all your celebrations and outreach efforts and they will be included on the APWA website.

For information on National Public Works Week or to get your copy of the 2004 National Public Works Week Poster "24/7: Focused on Our Community" call APWA at 800-848-APWA or log on to www.apwa.net.

Follow Othello's Lead

*By Jim Seitz, Transportation Specialist,
Association of Washington Cities*

The City of Othello is part of a national trend of updating traffic signals by installing energy efficient Light-Emitting Diode (LED) signals. The reasons for this trend:

- **Less Electricity:** LEDs use 80 to 90 percent less electricity.
- **Less Maintenance:** LEDs last 5-10 times longer.
- **More Safety:** LEDs are brighter and do not burn out unexpectedly.
- **More Savings:** Traffic lights are on 24/7 – money saved on electricity adds up fast!

Even with only five traffic lights, updating with LEDs added up to a smart investment for the City of Othello. Less maintenance makes a big difference to Othello.

Without a traffic crew to change incandescent traffic lights whenever they unexpectedly burn out, Othello had to wait for a company to replace them. With LED traffic signals lasting at least five years, lights can be replaced on a five-year schedule.

With the expertise of Western Traffic Systems, Othello started planning for LEDs in 2000. With money budgeted in 2001, Othello was ready to have the LEDs installed in February 2002.

If your city hasn't already joined this national trend, consider LEDs in your upcoming budget. You may also want to contact your electricity provider to inquire if they provide incentives or rebates for updating to LEDs.

LED traffic signals can provide an ongoing savings for your city!



WST2 Center Seeks Your Feedback

The WST2 Center is conducting a survey from readers of the WST2 newsletter. It is our focus to gather information on your agencies' needs and desires in areas such as training, technology, web site information, mousetraps, etc.

You can fill out the perforated questionnaire on the next page and mail or fax it to the WST2 Center. If you prefer, you can fill out the questionnaire online at:

<http://fmapps.wsdot.wa.gov/WST2survey>

The results of the survey will be used to help shape our future direction and to meet the needs and expectations of you, our readers. Thank you in advance for helping the WST2 Center remain one of the premier centers in the nation.

WST2 Center Questionnaire

Thank you for taking the time to give us your significant feedback. Your comments will be very helpful in furthering our commitment to providing a valuable and beneficial WST2 program. This form is also available for you to fill out online at <http://fmapps.wsdot.wa.gov/WST2survey>

1. What is your agency or organization?

- | | |
|---|---|
| <input type="checkbox"/> County | <input type="checkbox"/> Indian Nation |
| <input type="checkbox"/> City/ Town | <input type="checkbox"/> Other State Agency |
| <input type="checkbox"/> Port Authority | <input type="checkbox"/> Consultant |
| <input type="checkbox"/> Other (Please Specify) _____ | |

2. Which type of work do you do?

- | | |
|---|---|
| <input type="checkbox"/> Accounting/Finance | <input type="checkbox"/> Grants Administration |
| <input type="checkbox"/> Roadway Maintenance | <input type="checkbox"/> Engineering/Maintenance/Public Works |
| <input type="checkbox"/> Planning/Community Development | <input type="checkbox"/> Elected Official |
| <input type="checkbox"/> Executive Management | |
| <input type="checkbox"/> Other (Please Specify) _____ | |

3. Do you have access to the Internet? ☐ Yes ☐ No

How are you connected? ☐ T Line ☐ Cable ☐ DSL ☐ 56K ☐ 28K

4. Do you register for WST2 classes online? ☐ Yes ☐ No

How helpful has it been to register for classes online?

☐ Helpful ☐ Somewhat helpful ☐ Unhelpful

5. In the following areas, what courses not currently offered by WST2 would you like to see offered?

Project Management _____
Professional/ Technical _____
Maintenance _____
Other (Please Specify) _____

6. In these areas, how satisfied are you with the training courses WST2 provides?

Project Management	<input type="checkbox"/> Satisfied	<input type="checkbox"/> Somewhat satisfied	<input type="checkbox"/> Unsatisfied
Professional/ Technical	<input type="checkbox"/> Satisfied	<input type="checkbox"/> Somewhat satisfied	<input type="checkbox"/> Unsatisfied
Maintenance	<input type="checkbox"/> Satisfied	<input type="checkbox"/> Somewhat satisfied	<input type="checkbox"/> Unsatisfied
Comments _____			

7. How important are the following training information sources?

WST2 Educational Opportunities, distributed via e-mail from a listserv.

☐ Important ☐ Somewhat important ☐ Unimportant

WST2 Newsletter, training section.

☐ Important ☐ Somewhat important ☐ Unimportant

WST2 training web site.

☐ Important ☐ Somewhat important ☐ Unimportant

Training listserv.

☐ Important ☐ Somewhat important ☐ Unimportant

8. Do you use the online video training (Streaming Web Video)? ☐ Yes ☐ No

If yes, how helpful is this training format?

☐ Helpful ☐ Somewhat helpful ☐ Unhelpful

In the following areas, what courses not currently offered by WST2 would you like to see offered?

Project Management _____

Professional/ Technical _____

Maintenance _____

Other (Please Specify) _____

9. How often do you access the WST2 web site?

☐ Daily ☐ Once a week ☐ Once a month

☐ Other (Please Specify) _____

10. What type of information would you like added to the WST2 web site?

11. Have you visited the Build A Better Mousetrap web site? ☐ Yes ☐ No

If yes, has the information been helpful?

☐ Helpful ☐ Somewhat helpful ☐ Unhelpful

Comments _____

12. Do you have the current training video catalog? ☐ Yes ☐ No

13. In the following areas, what training videos not currently offered would you like to see offered?

Project Management _____

Professional/ Technical _____

Maintenance _____

Other (Please Specify) _____

14. Did your agency use the Roadshow program? ☐ Yes ☐ No

If yes, was the program valuable?

☐ Valuable ☐ Somewhat valuable ☐ Not valuable

Comments _____

Optional

Name _____ Agency _____

E-mail _____ Phone _____

Mail to: **WSDOT- WST2 Center**
PO Box 47390
Olympia, WA 98504-7390

Or fax to: **(360) 705-6858**

Strategies and Tools to Implement Transportation-Efficient Development: A Reference Manual

By Sarah Kavage, WSDOT Urban Planning Office

To encourage development that supports other travel modes, the Urban Planning Office at the Washington State Department of Transportation (WSDOT) completed a publication called *Strategies and Tools to Implement Transportation-Efficient Development: A Reference Manual*.

As the Puget Sound and other regions in the state grow, it is necessary to make roadways function more efficiently using ridesharing, public transit, walking, and bicycling. While targeted highway improvements can accommodate some travel demand and make the roadway system more efficient, other modes of travel will need to play a larger role in the region's future. Land use and urban design, in particular, have been shown by research and in practice to influence how people travel. Various land use strategies have generated interest as important ways to meet transportation objectives.

The Reference Manual represents an effort on behalf of WSDOT to research and document strategies that communities can use to

create a **transportation-efficient** built environment – one that is supportive of carpools, transit, and non-motorized travel. A tool for planners, executives, and stakeholders alike; the Reference Manual is the second phase of a larger, three-phase effort to help WSDOT identify potential actions and areas for future investment in regional highway corridors.

The Reference Manual looks at two types of strategies that can encourage transportation-efficient land use. **Regulatory strategies** are changes that can be made in development codes, street design, or in planning processes. **Financial strategies** provide financial incentives to property owners or developers or otherwise increase the economic viability of transportation-efficient development. Altogether, the manual discusses over 70 strategies that local agencies can and are using to implement transportation-efficient development. The strategies discussed in the manual can be used to concentrate urban development/redevelopment in centers, increase the supply and diversity of housing, and provide financing mechanisms.

Each section of the Resource Manual begins with a general discussion of each strategy, highlighting issues for consideration by policymakers. Illustrations and photographs aid in understanding the concepts and envisioning results. For those interested in more detail, the manual presents a more thorough explanation of how the strategies can function in implementation, local and national examples of how they have been used in other settings, and guidance on where and how they can best be applied. Research highlights and bibliographies in each section give more detail about the complex interactions between land use and transportation behavior.

The Resource Manual includes a large amount of available information in one place and is an excellent resource for local agency staff.

The Manual is available online at <http://depts.washington.edu/trac/reports/reports.html>. To obtain a copy in print or CD, or for more information, contact Sarah Kavage, WSDOT Urban Planning Office, at (206) 464-1267 or kavages@wsdot.wa.gov.





Words from the Chair

Those who fail to plan, plan to fail.
– George Hewell

Do you know where your pavement management program is going next year, in five years, in ten years? Planning for the future and predicting the consequences of decisions made today are at the heart of the pavement management discipline. In this issue, I would like to focus on a business planning effort currently underway at the City of Vancouver.

Government is changing. Three years ago, Vancouver's City Manager initiated the development of department level business plans. Rather than a "one size fits all" approach, the plan was to roll out the process slowly and methodically, and we were to learn as we go. Several city departments preceded us; now it is Transportation's turn. Our pavement management program is part of the Transportation Department and, while we are just beginning, there have been some things I have learned that I want to share with you.

So, what is business planning and what is a business plan? There are many books and Web sites devoted to the development of business plans for private industry. What about government? In the competitive market today, it is important that we provide value to our citizens. Do I clearly understand the mission and how to fulfill it? Do I understand the costs of carrying out the mission? Is the program improving?

For the City of Vancouver, business planning has been defined as the process of critically examining our customers, organization, internal processes, and finances to understand our organization and take

advantage of changes in the business environment. A business plan has been defined as a document that quantifies and identifies your businesses' current status and how you plan to react to the expected business environment within the planning horizon. The plan describes the organization in terms of lines of business, programs, services, and activities.

When faced with the prospect of working on a business plan, I looked at several Web sites and reference materials. One of the materials I read was *Business Plans for Dummies* (appropriately named) by Paul Tiffany and Steven Peterson. I found this reference very helpful in trying to understand the business planning process in private industry. After defining a business plan, it provides this perspective:

A business plan paints a picture of where your company has been and how it has changed over the years. By reviewing past performance, you can use your plan to figure out what worked and what didn't. In effect, your business plan offers you an opportunity to keep score, allowing you to set goals for your company to then keep track of your achievements.

As part of the planning process, it is important to establish a vision, mission, goals, and strategies. Vision defines a desired future and provides a clear and concise picture of the direction of the organization. Mission identifies the purpose for the program/service/department (what we provide). Goals relate directly to elements of the mission statement – how

the mission will be accomplished. Strategies outline specific steps to be taken over the short term and relate to specific programs or initiatives. The City of Vancouver's Transportation Department will be working to develop these elements as we work through the business planning process.

Business Plans for Dummies also speaks about identifying the company's values. Why are they important? The material answers this question as follows:

Your company faces all sorts of options, alternatives, and decisions every day that you're in business. If you take the time to define your company's values, these principles and beliefs can guide your managers, employees, or just you (if you're in business for yourself) as you face complicated issues that don't have easy answers. When the unexpected happens, you'll be able to react quickly and decisively, based on a clear sense of what's important.

The City of Vancouver embodies its values in its Operating Principles. Two of them that have particular importance for our pavement management program are shown below.

*City of Vancouver Operating Principle
on Stewardship*

The community of Vancouver entrusts us to care for its assets: its roads, its funds, its buildings, its parks, its equipment, its land, its water, its trees and its reputation. We are stewards even of its future. We must never gamble with it. We must conserve and enhance it, or we will have failed in our fundamental responsibility....

*City of Vancouver Operating Principle
on Fiscal Accountability*

The community entrusts us to manage their tax dollars wisely. We will be fiscally accountable in every action we take -- from major expenditures to small transactions. It is our duty and our responsibility to the citizens of Vancouver... Before any dollar is spent we will ask ourselves, "Is this necessary?", "Is this the best way to conduct the public's business?", "Is there a less expensive, equally effective alternative?" We will look for more cost-effective ways to provide services. We will ... work to balance resources with community priorities....

I have found both of these principles helpful in defining the mission of the pavement management program. For our agency, one of the most valuable assets is the pavement. The "pavement" is defined as the surface and underlying materials that support auto, bus, and truck loadings. The pavement management draft mission statement states:

The mission of the program is to effectively manage Vancouver's pavements by ensuring that they are designed in accordance with recognized standards and providing cost effective maintenance and rehabilitation activities. The program seeks to improve pavement life and achieve and sustain accepted pavement condition levels by developing design standards for new pavement construction, evaluating existing conditions, projecting needs, and determining priorities to implement maintenance and rehabilitation activities.

Although we have just started, the process has challenged me to ask myself if I can answer the following questions:

- Do I clearly understand the mission of the program?
- Am I measuring the right things?
- Do I know the condition of the network? How does it compare with previous condition surveys? How does it compare with our peers? How does the community feel about the network condition?
- Have I defined what constitutes an acceptable pavement condition? Do I know how much of the network is in this condition?
- What is the unit cost of performing our annual condition survey? Is it increasing, decreasing, staying the same?
- Do I know how much surfacing maintenance and rehabilitation is deferred both in terms of cost and lane miles of work required? How does this compare with last year? Is it increasing, decreasing, staying the same?
- Do I know what each activity in the pavement management program costs?
- For construction related activities, do I know how much was spent on design, construction, and construction administration? How does that match with industry norms?
- Do I know the unit cost of the construction activities (e.g. cost per lane mile of arterial street resurfaced, cost per lane mile of residential street resurfaced)?

I feel confident that I know the answers to some of these questions; others, I am not sure. What about you? Have you been involved in this process? Do you have any advice you might give as we work through our process? Have you found any reference materials that have been helpful to you, as you have wrestled with the same issues? Do you have a plan? I am looking forward to hearing from you. E-mail me at bill.whitcomb@ci.vancouver.wa.us.

In our Transportation Department, we have also been working on tools to improve citizen communications by describing some of our activities. I invite you to look at what we have done for pavement management. Simply go to <http://www.ci.vancouver.wa.us/transportation/brochures/pavement/pvmt.html>. Any comments to help us improve the next revision would be appreciated.

Finally, I feel strongly that the Northwest Pavement Management Association can only be successful if it is responsive to its membership and provides information and services that the membership finds valuable. I welcome any and all comments.

See you at the Fall Conference in October. Check our NWPMA web site for the most up to date information: <http://www.wsdot.wa.gov/TA/T2Center/Mgt.Systems/PavementTechnology/nwpma.html>.



Bill Whitcomb
Chairman, NWPMA
City of Vancouver, Washington



Here is what's on the Highways and Local Programs CD Library:

Technical Manuals – Pavement, Construction, Maintenance

1. A Guide for Local Agency Pavement Managers
2. Local Agency Pavement Management Application Guide
3. Pavement Surface Condition Field Rating Manual for Asphalt Pavements
4. Streetwise – A Simplified Local Agency Pavement Management System
5. WSDOT Standard Specifications: 2004 Edition
6. Gravel Roads Maintenance and Design Manual
7. Minnesota Seal Coat Handbook
8. Minnesota Seal Coat Research Project
9. Rockfall Catchment Area Design Guide
10. Dust Palliative Selection and Application Guide
11. Selecting a Preventive Maintenance Treatment for Flexible Pavements
12. Manual of Practice for an Effective Anti-icing Program – June 1996
13. Design Guidelines for the Control of Blowing and Drifting Snow – February 1994
14. Best Practices Handbook on Asphalt Pavement Maintenance
15. Manuals of Practice: Asphalt Pavement Crack Sealing and Pothole Repair
16. Concrete Pavement Repair Manuals of Practice
17. Sealing and Filling of Cracks for Bituminous Concrete Pavements
18. Insights Into Pavement Preservation
19. King County Erosion and Sediment Control Standards
20. Erosion Prevention and Sediment Control
21. Best Practices for Road Weather Management
22. A Guide for Selecting Anti-icing Chemicals
23. The Superpave Mix Design Manual for New Construction and Overlays
24. Pavement Maintenance Effectiveness
25. Making Pavement Maintenance More Effective, Training Supplement

26. Building Projects That Build Communities
27. Tips for Writing Grant Proposals
28. Determination of Insitu Material Properties of ACP Layers From NDT
29. Recommended Performance Guidelines for Emulsified Asphalt Slurry Seal
30. Asphalt Seal Coats, WSDOT/WST2, 2003
31. Superior Performing Asphalt Pavements (Superpave): Product of SHRP
32. Superpave Mixture Design Guide



Technical Manuals – Safety and Traffic

1. Local Agency Safety Management System
2. Standard Highway Signs: 2002 Edition (English)
3. Intersection Safety Briefing Sheets: An Introduction
4. Maintenance of Signs and Sign Supports for Local Roads and Streets
5. Guidelines for Design and Operation of Nighttime Traffic Control
6. Roundabouts: An Informational Guide
7. Work Zone Operations Best Practices Guidebook

Transportation Technotes

1. Tack Coats
2. Temperature Differentials in ACP Construction
3. Stone Matrix Asphalt (Sma)
4. Longitudinal Joint Construction Techniques
5. Dowel Bar Retrofit
6. Design And Construction for Concrete Intersections
7. Use of Rock Cap Materials as a Capillary Break
8. The Use of Novachip as a Surface Treatment

... and mousetraps, newsletters, and more!

News from FHWA Washington Division

*By Liana Liu, P.E., Traffic/Safety/
Research/T2 Engineer, FHWA
Washington Division*

2003 MUTCD - Interim Approvals

On February 6, 2004, the Federal Highway Administration (FHWA) issued an Interim Approval for the optional use of retroreflective borders on traffic signal back-plates. This information can be accessed via the MUTCD web site at http://mutcd.fhwa.dot.gov/res-interim_approvals.htm. Any question concerning this Interim Approval should be directed to Mr. Scott Wainwright at scott.wainwright@fhwa.dot.gov or by telephone at (202) 366-0857.

The Freeway Management and Operations Handbook

The FHWA is pleased to announce the availability of the Freeway Management and Operations

Handbook. This is a comprehensive revision to the previous version (1996), providing a more in-depth view of freeway management and operations and changes that have occurred to reflect the current state-of-the-practice.

Freeway management and operations involves the implementation of policies, strategies, technologies, and traffic management techniques that provide opportunities for improving the performance and overall traffic flow on these freeways.

This document can be accessed on the FHWA Freeway Management Program web page at <http://ops.fhwa.dot.gov/Travel/traffic/freetraffic.htm>. If you have any comments on the content or questions regarding the handbook, contact Mr. Jon Obenberger at jon.obenberger@fhwa.dot.gov or at (202) 366-2221.

Coming Attractions

- **Intersection Safety Resource CD** – a comprehensive compendium of resources and documents that practitioners can use in intersection design and operations.
- **Six New NCHRP Safety Implementation Guides** – these build on the six already available. See the web site at <http://www.safety.transportation.org>.
- **Road Safety Audits Brochure** – an overview of road safety audits, their benefits, and keys to success when implementing this technique to improve the safety of our roads.
- **Updated Road Safety Audit Web Site** – the current road safety audit web site (www.roadwaysafetyaudits.org) is being modified to add new content and redesigned to be more user-friendly.



Transportation Libraries Catalog

By Jennifer Boteler, WSDOT Librarian

The Transportation Libraries Catalog is a new "union catalog" of transportation related books and materials found in government, academic, and other transportation libraries in the United States.

A "union catalog" is a single catalog containing records of materials held by multiple libraries. Simply put, a union catalog shows who has what. To facilitate interlibrary resource sharing and cooperative purchasing programs, libraries have a long history of cooperating to create union lists or catalogs.

The grouping of libraries and resultant union catalogs can be based on several factors such as geographic location, subject of collections, or type of library. Here are some examples of other online union catalogs:

Summit: Orbis Cascade Alliance Union Catalog
<http://orbis.uoregon.edu/>

Summit is a library catalog that combines information from Orbis (consortium of academic libraries in Oregon) and Cascade (consortium of academic libraries in Washington State) into a single unified database. Summit can be searched directly from the Washington State Library / WSDOT Library online catalog via <http://cals.evergreen.edu/search%7ES2/>. After a search has been entered and the results displayed, there will be a green "Search Summit" button at the top of the page.

MERLN: Military Education & Research Library Network Group Catalog
<http://merln.ndu.edu/>

MERLN is a library catalog that includes books and other materials found in military libraries worldwide.

The National Transportation Library recently sent out the following announcement regarding the release of the Transportation Libraries Catalog:

Coordinated by the National Transportation Library (NTL), the Transportation Libraries Catalog enables the user to simultaneously search multiple transportation library collections held in OCLC¹. The union catalog reflects the collections of 20 libraries, including those of the Midwest Transportation Knowledge Network (MTKN) and others with significant collections. Institutions with transportation specific libraries (and holdings in OCLC) are welcome to participate in the Transportation Libraries Catalog.

The Transportation Libraries Catalog provides access to a customized union catalog of transportation libraries' bibliographic records. Researchers may search the collections of participating libraries in a single click, or they may limit their search to a specific group of transportation libraries: Government Transportation Libraries, University Transportation Libraries, and Midwest Transportation Libraries.

Guest Access to the Transportation Libraries Catalog is available at www.ntl.bts.gov

The following transportation libraries are participating in the premier of the Transportation Libraries Catalog:

Illinois Department of Transportation
 Iowa Department of Transportation
 Kansas Department of Transportation
 Los Angeles County MetroTransit Authority
 Michigan Department of Transportation
 Minnesota Department of Transportation
 Missouri Department of Transportation
 Northwestern University, Transportation Library
 Ohio Department of Transportation
 South Dakota Department of Transportation
 Transportation Research Board
 University of California Berkeley, Transportation Library
 University of Michigan, Transportation Research Institute
 Virginia Transportation Resource Council
 Wisconsin Department of Transportation

The "Guest Access" mentioned in this announcement means that the catalog is currently available to the public for free through the National Transportation Library. Based on funding, future access to the Transportation Libraries Catalog through the NTL may not be guaranteed.

The Washington State Department of Transportation (WSDOT) Library plans to join the Transportation Libraries (Union) Catalog, and it is expected that the WSDOT Library holdings will be included by July 2004.



For questions about the Transportation Catalog or union catalogs in general, contact the WSDOT Library at library@wsdot.wa.gov or (360) 705-7751.

¹OCLC Online Computer Library Center is a nonprofit, membership, computer library service and research organization dedicated to the public purposes of furthering access to the world's information and reducing information costs. More than 45,000 libraries in 84 countries and territories around the world use OCLC services to locate, acquire, catalog, lend and preserve library materials. <http://www.oclc.org/about/default.htm>



By Roger Chappell, Technology Integration Engineer, WSDOT Highways & Local Programs WST2 Center

Unlike gypsy fortunetellers gazing into crystal balls and predicting the future, the modern crystal ball is simply a computer screen and millions of bytes of data. A technological crystal ball needs to be as easy to use as a video game, with the brains and speed of a super computer. The purpose for a mythical crystal ball is to predict and control the future and the same holds true for building its computerized equivalent. A computerized crystal ball would give me the ability to know enough about the future to manage or invest wisely and avoid undesirable events. I would also like it to predict events with some measure of certainty and have the ability to tweak the variables so that I could generate an array of ranked options in order to choose the optimum solutions. It would give me the ability to customize the output so that the solutions offered would be in alignment with both my short and long term goals and strategic plans.

We have been working toward the goals of trend analysis and predictive modeling in the management systems arena for a long time, and

I believe, in the near future, it will be possible to develop a computerized crystal ball. It has only been within the last few years that computer hardware and software have evolved to make it possible to do realistic predictive modeling and solution simulation. So far, the applications are still relatively isolated, and the results need further validation. More work still needs to be done in the areas of data and application integration.

Because this technology and the words that define it are in a constant state of evolution, the following is a brief attempt to define some of the techno-babble spoken in the technological crystal ball world.

Data

In its simplest form, data is a description of an object or an event. The descriptions of the "real world" are the basic building blocks of a virtual world. The better the quality and quantity of data, the better the end results will be or the more realistic my virtual world becomes.

Data Neutrality

Data neutrality means that I am comparing apples with apples and oranges with oranges or similar data elements. A picture

is a relatively unbiased data source. Although it is subject to interpretation, all the data required to make the interpretation is contained in the picture. A picture of a guardrail is, after all, a picture of a guardrail. If I send a crew to collect data about the same guardrail, they can only draw me a picture with words. If I send a different crew, they may or may not use the same words. In either case, my data would be subject to the interpretation and abilities of my field crews. The reason I like imaging products is because I want the best representation and most consistent words I can get, especially if the adage is true that a picture is worth a thousand words.

Critical Data

Critical data are the core data elements that make up the framework of data needed by the program. They may also refer to the data that you will need to answer the problems of tomorrow at some point in the future. In order to start building the historical trends needed for tomorrow, you need to start gathering this type of data today.

Dynamic Metadata

Metadata is just data about data. It is the how, when, and why the data was created and how best to

use it. Dynamic metadata is meta-data that can be easily searched through, much like a search engine on the web searches through meta tags to find the content it is searching for.

Trend Analysis

Trend analysis is the process of looking at patterns in data over time to develop performance trends. For example, Pavement Management Systems are able to chart the performance of various types of paving materials to determine how long they will last. These trends are typically charted as a descending bell curve, starting with new pavement at the top and ending with something like gravel at the bottom. If I know a certain paving material has a fifteen-year life expectancy, I can predict when is the most cost effective time to rehabilitate the pavement to maximize its projected lifespan. The better the quality and quantity of data, the better the trends will be.

Predictive Modeling

Predictive modeling builds on trend analysis by comparing the performance of the trends to a predicted world model. To use the Pavement Management System example, now that I have my pavement trends, I can subject them to data that more closely resembles the behavior and environments of the actual pavements. Data such as amount and severity of defects (cracking), amount and weight of traffic, and soil types may play a significant role in how well a pavement actually performs. The more accurately I can predict when to perform the appropriate preventive maintenance, the more money I will save. For example, I can change the oil in my car every 100 miles, but I would be throwing away perfectly good oil. On the other hand, if I never change the oil, I would expect very costly

repairs much sooner. Predictive modeling looks at all the data and variables and attempts to provide a solution or an array of solutions based on the modeled world. The better the data comprising the modeled world, the better the predicted results for it will be. This translates into more cost saving and successful management of the asset.

Simulation Modeling

Simulation modeling allows you to play with your predictions, tweak the variables, and test the results all in the environment of a virtual world. Simulation testing also allows you to optimize your predicted solutions before testing them on the motoring public. If you are trying a new solution that lacks enough data, a virtual world simulation model would allow you to test a wide variety of variables before going public.

To summarize:

- Data is the foundation on which the crystal ball rests; it is the building blocks of the virtual world.
- Trend analysis shows how things behave over time in a virtual world.
- Predictive modeling is the crystal ball vision into the future, based on a predicted virtual world.
- Simulation modeling has the ability to play with the predicted future and solutions in order to optimize the results.

How hard is it to manipulate virtual worlds? I guess it all comes down to your "level of play," as my six-year-old grandson would say. He is already playing video games better than I. Even at the early age of six, he knows that dad's level of play is much higher than grandpa's level of play, and

he can beat me at least six out of ten games. For now, I can still hold my own against my four-year-old grandson, but it is getting more difficult. Video gaming is simply changing variables in a virtual world. My grandson will hit the job market with a skill set that contains 15+ years experience in manipulating the best virtual worlds that industry has to offer, and I have no doubt that he will win.

If we can make transportation predictive modeling and virtual world simulation as easy as playing a video game, just imagine what the next generation will be able to do with it. Imagine if you could give these young traffic engineers of tomorrow a simulation model of an intersection. In this virtual world model, you are able to place vehicles and control their speeds. Using AI (Artificial Intelligence) and Fuzzy Logic, the program would also be able to mimic driver behavior patterns. The object of the game is to see how many virtual vehicles of various sizes can pass through an intersection or series of traffic impediments in a twenty-four hour period safely. The player with the highest traffic flow wins. By the way, be careful of driver behavioral patterns; sometimes chaos theory prevails. I don't know if this will lead to breakthroughs in intersection design, but I do know that it is the best environment to push the limits, test new designs, and to explore the unknowns.

What kind of questions would you like to ask a crystal ball? No lottery numbers, please. How about transportation related questions for starters. If I were a traffic engineer, I might want to know the optimum intersection configuration and design for every intersection under my jurisdiction. The computerized crystal ball on your desktop might start with all the data it could

gather on intersection performance. It could also start working with data like ADT (Average Daily Traffic) volumes. If it had ADT data spanning twenty years, it could evaluate the trends and chart a predictive growth curve. It might then overlay the growth curves from other variables such as population growth and migration pattern curves, new business starts, and other economic indicators. By comparing these trends in the data it would also be able to match these trends with other intersections that exhibit similar behavioral patterns.

By using regressive modeling techniques, the crystal ball would be able to find intersections that are earlier in their developmental processes than others. It would be able to “see” an intersection that has changed from a four-way stop to a roundabout or interchange. During this change, you could view the effects of adding signalization, turning movements and storage, and optimal signal timing, both individually and as part of a network. By regressing through the evolutionary lives of the more advanced intersections, it could suggest positive solutions to implement and negative impacts to avoid. It could also suggest at what stage of development the solutions should be implemented.

The better the data history, the better its trend analysis will be. The better the trend analysis, the better the predictive modeling will be. The degree to which its “predicted world” matches the “real world” will determine how successful the implementation will be.

If I implement a change too early in the development cycle, I may contribute to accelerated growth rates (e.g. urban sprawl) and thus accelerate my predicted trends. If I implement a change too late, I may be faced with heavy traffic congestion and drivers exhibiting high-risk behavior. This isn’t magic. The timing and outcomes should be based on the data and should be relatively easy to predict. The crystal ball needs good data and the ability to constantly monitor the changes and adjust. This will require a lot of data and analysis but, fortunately, intersections and roadway networks tend to change fairly slow over time.

As I begin to implement intersection management changes, I will want a variety of other data for incremental decision-making. For example, Lidar and orthophotography can help, not only to plan where in the real world changes are going to take place, but they can also help to predict how many yards of material will need to be moved. Depending on the data quality, your estimates for cut and fill could be within a 10-yard dump truck. GIS soil layers should give you a rough idea as to the type of soils you will encounter and also any drainage or environmental concerns. If you have layers that contain right of way plans, there may be other information needed. GBI (Ground Based Imaging) will give you the ability to virtually drive down the road and identify information such as private accesses, mailboxes, illumination, signs, culverts, and other features that you will need to consider.

There are also programs on the horizon using Fuzzy Logic and neural networks for pattern recognition that will increase the speed of data processing and trend building processes. Imagine that we loaded 200 images of apples into a neural net program. The computer now has the ability to recognize what apples look like or, better yet, it has learned about apples. The more data in the sample dataset, the better the chances are that the program will accurately recognize the pattern correctly. The more I define the data in the images, the better complex patterns will be recognized and learned about. For example, if I identified the images that contain red apples and the ones with green apples, my program can not only find the apples, it can also sort them by color. If I define the fuzzy percentages, I can now sort the apples that are varying shades between red and green. If you can teach the program to sort apples, can it be taught to recognize bridges, guardrails, and signs?

Along with smarter software, the hardware to use it is also available. Today, you can build a super computer for less than the price of a new car. Mini cluster super computers and Grid based computing hold the potential for handling terabytes of data and processing it at teraflops of speed. In other words, lots of data processed really fast and cheap. Hold on tight because the future is coming, and I predict there are some exciting times ahead.



WST2 Resources

*Free Publications from Your WST2 Center
For State of Washington residents only due to high mailing costs.*

Name	Agency		
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Phone	Fax	E-mail	

Order direct from the WSDOT home page:

<http://www.wsdot.wa.gov/TA/T2Center/T2PUBS.htm>

Or you may fax the form to (360) 705-6858; or mail the form to WST2/WSDOT, H&LP, P.O. Box 47390, Olympia, WA 98504-7390; or e-mail your request to WST2Center@wsdot.wa.gov; or phone (360) 705-7386.

☒ Check the items you would like to order.

Hard Copy Publications

- ☐ Accessible Sidewalks and Street Crossings, FHWA, 2003
- ☐ Asset Management Primer, FHWA, 1999
- ☐ Audio Visual Catalog, T2 Center
- ☐ Chip Seal Application Checklist
- ☐ Concrete PASER Manual, University of Wisconsin, 1998
- ☐ Contracting for Professional Services in Washington State, MRSC, 1994
- ☐ Crack Seal Application Checklist, FHWA, 2001
- ☐ Data Integration Primer, FHWA, 2001
- ☐ Designing Sidewalks and Trails for Access, Part 2, FHWA, 2001
- ☐ Dust Control on Low Volume Roads, FHWA, 2001
- ☐ Entering the Quiet Zone: Noise Compatible Land Use Planning, FHWA, 2002
- ☐ Family Emergency Preparedness Plan, American Red Cross, et al., 1999
- ☐ Field Guide for Unpaved Rural Roads, Wyoming T2 Center, 1997
- ☐ Fish Passage Through Culverts, FHWA, USDA, 1998
- ☐ Fog Seal Application Checklist
- ☐ General Field Reference Guide (Pocket Size), 2002
- ☐ Geotextile Selection and Installation Manual for Rural Unpaved Roads, FHWA, 1989
- ☐ Getting People Walking: Municipal Strategies to Increase Pedestrian Travel, Rhys Roth, Energy Outreach Center
- ☐ A Guide for Erecting Mailboxes on Highways, AASHTO, 1984
- ☐ HMA Pavement Smoothness, FHWA, 2002
- ☐ Improving Conditions for Bicycling and Walking, FHWA, 1998
- ☐ Improving Highway Safety at Bridges on Local Roads and Streets, FHWA, 1998
- ☐ Joint Sealing Portland Cement Concrete Pavements, FHWA, 2002
- ☐ Maintenance of Aggregate and Earth Roads, WST2 Center (1994 reprint)
- ☐ Manual for Controlling and Reducing the Frequency of Pavement Utility Cuts, FHWA, 2002
- ☐ Microsurfacing Application, FHWA, 2002
- ☐ Planning & Implementing Pedestrian Facilities in Suburban and Developing Rural Areas, TRB, 1987
- ☐ Recommendations to Reduce Pedestrian Collisions, WSDOT, December 1999

- ☐ Redevelopment for Livable Communities, Rhys Roth, Energy Outreach Center, 1995
- ☐ Reflective Sheeting Identification Guide, FHWA, 2001
- ☐ Scenic Byways Map of Washington State, 2003
- ☐ School Administrator's Guide to School Walk Routes and Student Pedestrian Safety, Washington Traffic Safety Commission and WSDOT, 2003
- ☐ Soil Bioengineering: An Alternative for Roadside Management, USDA-FS, 2000
- ☐ State-of-the-Art Survey of Flexible Pavement Crack Sealing Procedures in the United States, CRREL, 1992
- ☐ Thin Hot-Mix Asphalt Overlay
- ☐ Trail Construction & Maintenance Notebook, USDA Forest Service, 2000
- ☐ Utility Cuts in Paved Roads, Field Guide, FHWA, 1997
- ☐ W-Beam Guardrail Repair and Maintenance, FHWA, 1996
- ☐ A Walkable Community is More Than Just Sidewalks, FHWA, 2000
- ☐ Washington Bicycle Map, WSDOT, 2001
- ☐ Washington State Highway Map, WSDOT, 2002
- ☐ Wetland Trail Design and Construction, USDA, 2001
- ☐ Wildlife Habitat Connectivity Across European Highways, FHWA, 2002

Workbooks and Handouts from WST2 Center Workshops

- ☐ Application of Geographic Information Systems for Transportation, FHWA, 1999
- ☐ Construction Documentation: Construction Training Manual for Local Agencies, WSDOT, 2003
- ☐ Environmental Overview, LAG Manual Chapter 24, WSDOT, 2003
- ☐ Geosynthetics Engineering Workshop, NHI
- ☐ Handbook for Walkable Communities, by Dan Burden and Michael Wallwork
- ☐ Restoration of Aquatic Species Passage Using Stream Simulation, 2003

Videotapes

- ❑ Driving Modern Roundabouts, City of Lacey, City of Olympia, and WSDOT, 2002
- ❑ Walkable Communities: Designing for Pedestrians, Dan Burden, \$50/set of four videotapes

CD ROM

- ❑ H&LP CD Library, 5th Edition, Winter 2003 contains the following publications and other technical documents:
 - Asphalt Pavement Repair Manuals of Practice, SHRP, 1993*
 - Asphalt Seal Coats, WSDOT/WST2 Revised 2003*
 - Building Projects that Build Communities, Community Partnership Forum, 2003*
 - Concrete Pavement Repair Manuals of Practice, SHRP, 1993*
 - Dust Palliative Selection and Application Guide, USFS, 1992*
 - Gravel Roads Maintenance and Design Manual, South Dakota LTAP, November 2000*
 - A Guide for Local Agency Pavement Managers, NWT2 Center, 1994*
 - Local Agency Pavement Management Application Guide, WST2 Center, 1997*
 - Local Agency Safety Management System, WSDOT, 1998, Reprinted 2000*
 - Maintenance of Signs & Sign Supports for Local Roads and Streets, FHWA, 2001*
 - Manual of Practice for an Effective Anti-icing Program: A Guide for Highway Winter Maintenance Personnel, FHWA, 1996*
 - Pavement Surface Condition Field Rating Manual for Asphalt Pavement, NWPMA, WSDOT, 1999*
 - Roundabouts: An Information Guide, FHWA, 2000*
 - Streetwise, A Simplified Local Agency Pavement Management System, WSDOT, 2000*

Some of the publications on the CD Library are still available in hard copy within Washington State only.

Other CDs

- ❑ Driving Modern Roundabouts, City of Lacey, City of Olympia and WSDOT, 2002*
- ❑ Pedestrian/Bicycle Crash Analysis Tool, FHWA, 1999
- ❑ Pedestrian Facilities Guidebook, WSDOT, 1997
- ❑ Tools for Identifying Land Use Areas with Potential for Pedestrian Travel and Prioritizing Investments, UW/WSDOT, 2001

DVD

- ❑ Driving Modern Roundabouts, City of Lacey, City of Olympia and WSDOT, 2002*

Non-Credit Self-Study Guides

These non-credit WSDOT self-study guides may be obtained from the WST2 Center. An invoice will be sent with the books.

- Basic Surveying, \$20
- Advanced Surveying (metric), \$20
- Contract Plans Reading, \$25
- Technical Mathematics I, \$20
- Technical Mathematics II, \$20
- Basic Metric System, \$20



Bridge

- WSDOT Highways & Local Programs
<http://www.wsdot.wa.gov/TA/Operations/BRIDGE/BRIDGEHP.HTM>

Environmental

- *Environmental Procedures Manual* (M31-11)
<http://www.wsdot.wa.gov/fasc/EngineeringPublications/Manuals/EPM/EPM.htm>
- Regional Road Maintenance Endangered Species Act Program Guidelines
<http://www.metrokc.gov/roadcon/bmp/pdfguide.htm>
- National Marine Fisheries Service Species Listings & Info
<http://www.nwr.noaa.gov/>
- U.S. Fish and Wildlife Service Species Listings & Info
<http://endangered.fws.gov/>
- Washington State DNR's Natural Heritage Program Home Page
<http://www.wa.gov/dnr/htdocs/fr/nhp/refdesk/fsrefix.htm>
- FHWA's Environmental Home Page
<http://www.fhwa.dot.gov/environment/index.htm>

Highways & Local Programs List Serves

- Local Agency Guidelines (LAG) Manual
<http://lists.wsdot.wa.gov/guest/RemoteListSummary/LAGG>
- Traffic and Safety Management
http://www.t2sms-l@lists.wsdot.wa.gov/guest/RemoteListSummary/T2SMS_L
- Pavement Management
http://lists.wsdot.wa.gov/guest/RemoteListSummary/T2PAVE_L
- WST2 Newsletter
http://lists.wsdot.wa.gov/guest/RemoteListSummary/T2News_L
- WST2 Training
http://lists.wsdot.wa.gov/guest/RemoteListSummary/T2TRNG_L

WSDOT Materials Lab

- <http://wsdot.wa.gov/biz/mats/htm>

Infrastructure Management & GIS/GPS

The site below has been established to promote interagency data exchange and resources sharing between local governmental agencies.

<http://www.wsdot.wa.gov/TA/T2Center/Mgt.Systems/InfrastructureTechnology/InfThp.html>

Legal Search

- Search RCWs and WACs
<http://search.leg.wa.gov/pub/textsearch/default.asp>
- City Streets as part of State Highways
<http://www.wsdot.wa.gov/TA/Operations/LAG/CityStreets.html>

Local Agency Guidelines (LAG) Manual

<http://www.wsdot.wa.gov/TA/Operations/LAG/LAGHP.htm>

Pavement Management

- Pavement Publications & NWPMA Links
<http://www.wsdot.wa.gov/TA/T2Center/Mgt.Systems/PavementTechnology>
- NWPMA - North West Pavement Management Association
<http://www.wsdot.wa.gov/TA/T2Center/Mgt.Systems/PavementTechnology/nwpma.html>
- Asphalt Institute
<http://www.asphaltinstitute.org/>
- National Asphalt Pavement Association
<http://www.hotmix.org/>
- Pavement (A Web Site for Managing Pavements)
<http://www.mincad.com.au/pavenet>
- SuperPave Information
<http://www.utexas.edu/research/superpave>

Project Development

- Federal Aid Progress Billing Form
<http://www.wsdot.wa.gov/TA/ProgMgt/Projectinfo/BILLFORM.XLS>
- State Funded Progress Billing Form
<http://www.wsdot.wa.gov/TA/ProgMgt/Projectinfo/BILLFORMSTATE.xls>
- STIP (State Transportation Improvement Program)
<http://www.wsdot.wa.gov/TA/ProgMgt/STIP/STIPHP.htm>

- TIP (Local Agency 6-Year Transportation Improvement Program)
<http://www.wsdot.wa.gov/TA/ProgMgt/STIP/TIP.html>

Research

- WSDOT Research Office
<http://www.wsdot.wa.gov/ppsc/research>
- Looking for a Transportation Research Publication?
<http://www.nas.edu/trb/index.html>
- Municipal Research and Services Center of Washington
<http://www.mrsc.org>

Traffic & Safety

- Safety Management Publications & Information
<http://www.wsdot.wa.gov/TA/T2Center/Mgt.Systems/SafetyTechnology/>
- WSDOT Traffic Data Office
<http://www.wsdot.wa.gov/mapsdata/tdo/>
- Washington State Patrol
<http://www.wa.gov/wsp/wsphome.htm>
- Washington Traffic Safety Commission
<http://www.wa.gov/wtsc>
- National Highway Traffic Safety Administration
<http://www.nhtsa.dot.gov>
- American Traffic Safety Services Association
<http://www.atssa.com>
- Municipal Research and Services Center of Washington
<http://www.mrsc.org>
- Transportation Research Board
<http://www.nas.edu/trb/index.html>

Training

- WST2 Classes & LAG Training
<http://www.wsdot.wa.gov/TA/T2Center/Training/>
- WST2 Class Registration
<http://www.wsdot.wa.gov/TA/T2Center/t2hp.html>
- County Road Administration Board
<http://www.crab.wa.gov/>
- American Public Works Association
<http://www.apwa.net/education>
- Transportation Partnership in Engineering Education Development (TRANSPED)
<http://www.engr.washington.edu/epp>

WSDOT Local Programs Engineers

- Eastern Region (Spokane)
Keith Martin (509) 324-6080,
martink@wsdot.wa.gov
- Northwest Region (Seattle)
Terry Paananen (206) 440-4734,
paanant@wsdot.wa.gov
- Olympic Region (Olympia)
Neal Campbell (360) 357-2666,
campben@wsdot.wa.gov
- North Central Region (Wenatchee)
Paul Maher (509) 667-3090 or 667-2900,
maherp@wsdot.wa.gov
- South Central Region (Yakima)
Roger Arms (509) 577-1780,
armsr@wsdot.wa.gov
- Southwest Region (Vancouver)
Bill Pierce (360) 905-2215,
pierceb@wsdot.wa.gov

Other Online Resources

- Bicycle maps and other information
<http://www.wsdot.wa.gov/TA/PAandI/PAIHP.html>
- Pedestrian information
<http://www.wsdot.wa.gov/TA/PAandI/PAIHP.html>
- Rural Partnerships and scenic byways information
<http://www.wsdot.wa.gov/TA/PAandI/PAIHP.html>
- Better Mousetraps
<http://www.wsdot.wa.gov/ta/T2Center/Mousetraps/>
- Retired Professional Program
<http://www.wsdot.wa.gov/TA/T2Center/Retired.htm>
- Student Referral Program
<http://www.wsdot.wa.gov/TA/T2Center/StudentReferral/>
- LTAP (Local Technical Assistance Program) Clearing House
<http://www.ltapt2.org>
- Institute of Transportation Engineers
<http://www.ite.org>
- Washington State Counties
<http://access.wa.gov/government/awco.asp>
- Washington State Cities and Towns
<http://access.wa.gov/government/awcity.asp>
- Governor's Office of Indian Affairs
<http://www.wa.gov/goia/index.html>
- Southwest Interagency Coop - Grounds Equipment Maintenance (GEM)
<http://www.gematwork.org>

Training Opportunities



*Laurel Gray, WST2
Training Program
Coordinator*

Washington State T2 Center

Contact: Laurel Gray (360) 705-7355
Wendy Schmidt (360) 705-7386
<http://www.wsdot.wa.gov/TA/T2Center/Training>

To register for a class in this section, use the contact listed above.

The class fees shown apply to both public and private sector students. Classes marked with an asterisk (*) qualify under the Road and Street Management Training Program as a requirement or an elective and contribute to a Certificate of Achievement (CA) in Road and Street Management.

Pavement Condition Rating*

May 4-5, Ellensburg; June 1-2, Tacoma; September 7-8, Tacoma. Free. Instructor: Bob Brooks. Participants will learn to rate the pavements commonly found in Washington. The rating values obtained using the definitions and methods learned in this course should compare favorably with those obtained and used in the Washington State Pavement Management System. Each participant should be able to perform a pavement condition survey with reasonable objectivity.

Cultural Resources Training

May 4-7 and October 5-8, The Dalles, Oregon. \$350. Cultural Resources training takes place twice a year in the spring and fall. This training will introduce participants to the value and significance of Washington's irreplaceable cultural resources. This class provides an exceptional opportunity for local agencies to work with the Northwest's most qualified instructors, visiting some of the area's finest examples of cultural resources, and attending the only statewide

training session of this caliber. There will be presentations by Native Americans on their cultural perspective; speakers on state archaeology, prehistory of Washington, Native American ethnobotany, prehistoric stone artifacts, rare plants, logging in the northwest, and federal and state cultural resource regulations and how they apply to your agency. There will be in-field lessons on how to "read" the landscape and recognize the probable cultural resources located at the site, and sharing preservation techniques and strategies. This training is for any individual who wants to become knowledgeable about cultural resources and possess the necessary skills to address basic resource management problems associated with cultural resources. Call the WST2 Center to have your name placed on a wait list; these two classes are not available for online registration.

Roadway Drainage*

May 6, Marysville; May 12, Tacoma. \$45. Instructor: Bill Heiden. This course will discuss basic road design characteristics as it relates to drainage, soil characteristics, basic hydrology (drainage areas, runoff factors, rainfall intensity), hydraulics (culvert materials, sizing culvert, sizing ditches), placement of culverts, culvert end treatments, and culvert and ditch maintenance. The course is intended to cover the needs of all people responsible for roads, from managers to operators. The course will not provide design criteria for engineers.

Basics of a Good Gravel Road*

May 11, Tacoma. \$45. Instructor: Bill Heiden. This is a basic road maintenance class. All major problems of unpaved gravel roads will be addressed: washboarding (corrugation), traffic patterns, rutting, surface drainage, dust control, surface material, and roadside obstruction. The techniques that Mr. Heiden teaches can help to reduce unpaved road maintenance expenditures by up to 40 percent of current expenditures in three to five years.

A Forum for the 2003 MUTCD State Adoption Process

May 13, Vancouver; May 19, Spokane; May 20, Yakima. Free. Meetings are 8:30 a.m. to noon. FHWA recently released a new MUTCD – the 2003 MUTCD. State law requires WSDOT to formally adopt the 2003 MUTCD before it can be used in Washington State. WSDOT adopts the MUTCD and modifications through Washington Administrative Code 468-95. Modifications are to be made to meet Washington State law or state practice. WSDOT and counties must fully conform to the adopted uniform standards. Cities are required to conform to the uniform standards to the

extent possible. The first step in the adoption process is a statewide series of modification forums. This is an opportunity for transportation stakeholders to learn about the adoption process, discuss the 2003 MUTCD, and propose modifications to the 2003 MUTCD. A Technical Review Committee will advise WSDOT by reviewing and prioritizing proposed modifications. FHWA must approve any proposed modifications to the 2003 MUTCD. If you would like to take part in the modification process, plan to attend one of the meetings in Vancouver, Spokane, or Yakima. Meetings were held in Bellevue in April.

Contract Specification Writing (LAG Program)

May 27, Camas; September 29, Seattle; October 13, Bellingham; November 9, Tumwater. \$50. Instructor: Steve Boesel. This class will provide guidance and methods for writing consistently clear, concise, complete, and well-formatted contract special provisions. It will provide a thought process that can be used when writing or reviewing contract specifications to ensure the greatest possibility for a successful bid and a successful construction project.

Writing Skills*

June 22-23, Fife. \$110. Instructor: Jordan Peabody. This is a two-day workshop designed to reduce the confusion caused by the poorly written word. Anyone who must write on the job, but is not a writing pro, will find the training both pleasant and helpful. Writing techniques apply to: letters, manuals, speeches, memos, newsletters, e-mail, proposals, reports, bulletins, and minutes.

Environmental Overview Workshop

September 9, Mount Vernon; September 15, Tumwater; September 22, Vancouver; September 29, Port Angeles; October 5, Spokane; October 6, Moses Lake; October 27, Seattle; November 3, Tri-Cities. Free. This course will give a basic understanding of environmental procedures and documentation, when they apply, what they are, and how to properly fill out the paperwork. Specific topics will include: Informal and Formal Consultation for Endangered Species Act issues, Memorandums of Agreement for Adverse Cultural/Historical Effects, Programmatic Section 106 Exemptions, Tribal Section 106 Relations and Traditional Cultural Properties, 4(f) Evaluations, guidance on air quality, noise impacts, environmental justice, Environmental Assessments, and Environmental Impact Statements. This course is for local agency staff or consultants who are responsible for environmental procedures and documentation of projects.

Appraisal Review Overview (LAG Program)

September 28-29, Kelso. \$100. Eminent domain appraisal review for projects using federal highway dollars is a narrow specialty within the appraisal and right of way profession. Many individuals performing these duties do so on only an occasional or part-time basis. This day and a half course addresses part of the training needs of this specialized assignment. The course schedule includes:

- Appraisal expectations outlined in The Uniform Act (Uniform Relocation Assistance and Real Property Acquisition Policies Act).
- Local Agency Guidelines concerning appraisal (LAG Chapter 25).
- Eminent Domain Law, R/W plans, and the Uniform Act - Short Case Studies.
- Appraisal Review Overview.
- Recurring Appraisal Review Issues and Case Studies.
- Resources for Eminent Domain Appraisers and Review Appraisers.

Making Effective Presentations*

October 6, Tacoma. \$85. Speaking before a group is a skill that can be learned and involves knowing how to prepare and practice to accomplish your desired results. This workshop gives you practice in developing your communication skills and presenting your ideas clearly, confidently, and persuasively. Participants will learn how to: (1) select, plan, and prepare topics for presentation to a group in a business setting, (2) present 2-3 topics during the duration of the class using the structure and techniques taught in the workshop, and (3) evaluate the effectiveness of presentations by applying elements of constructive critique.

Introduction to GPS Mapping Grade Equipment

\$325. This is a three-day, special-request class. Instructor: Max Schade. Sessions can be scheduled in the WSDOT Olympic Region training room in Tumwater, WA or scheduled in your agency. Fee is based on four students per session. This is an introductory course on mapping grade GPS equipment and is taught by a Trimble-certified instructor. It is designed to provide basic knowledge and skills in the use of GPS technology in mission planning, data gathering, and data processing. The training will enable field operation personnel to use new methods and Trimble mapping grade equipment as well as understand problems encountered when using the GPS satellite constellation.

LAG Training Program

Unless otherwise stated, the courses in the LAG program are free.

- **Appraisal Review Workshop:** *LAG Manual* Chapter 25. \$100. One session scheduled September 28-29 in Kelso. See page 38 for class description.
- **Construction Documentation:** *LAG Manual* Chapters 51, 52, and 53. Classes will be scheduled for November 2004 through April 2005.
- **Consultants:** *LAG Manual* Chapter 31. Training is now offered by the University of Washington under the title "Managing Consultants" and is available through the TRANSPEED program. See the TRANSPEED section on page 41.
- **Contract Specification Writing:** *LAG Manual* Chapters 42-46. \$50. 2004 sessions are now scheduled. See page 38 for details.
- **DBE/EEO/OJT:** *LAG Manual* Chapters 26 and 27. This class will provide local agencies with a basic understanding of the rules and procedures on Disadvantaged Business Enterprise (DBE), Equal Employment Opportunity (EEO), and On-the-Job Training (OJT) for federally funded projects. There are no sessions scheduled at this time.
- **Emergency Relief Programs:** *LAG Manual* Chapter 33. Curriculum is now available on CD. The course covers instructions on procedures applicable to emergency projects funded by the Emergency Relief Program on federal-aid highways and by the Federal Emergency Management Agency disaster assistance for projects not on federal-aid highways. Call the WST2 Center to order your copy of the CD.
- **Enhancement Program:** *LAG Manual* Chapter 62. Training will be developed when a new Federal act is in place.
- **Environmental Overview for Local Agencies:** *LAG Manual* Chapter 24. Classes are now scheduled for fall 2004. See page 38 for details. This course is also an elective in the Road and Street Management Program.
- **Right of Way Procedures Workshop:** *LAG Manual* Chapter 25 and the Federal Perspective. There are no sessions scheduled at this time.
- **Right of Way Plans Preparation:** *LAG Manual* Chapter 25. This is a 4-hour class. \$50. There are no sessions scheduled at this time.

- **LAG Manual Overview:** This course will give a basic overview of the *Local Agency Guidelines Manual* and the latest revisions. There are no sessions scheduled at this time.

It is important that you let us know if you have an interest in any of the courses listed above by logging on to our web site at <http://www.wsdot.wa.gov/TA/T2Center/T2hp.htm> and accessing the online request list. Click on "WST2 On-Line Request," fill out the form, and send. Individual classes will be developed in response to the request lists. If your name is on the list, you will be notified by e-mail when classes are scheduled.

If you have questions about the LAG Program, contact Larry Schofield at (360) 705-7380 or schofil@wsdot.wa.gov.

The Endangered Species Act (ESA) Training Program

Training Program Streamlined and Updated

During this past fall and early winter, the ESA program has undergone a major review, and based on the feedback and evaluations of the University of Washington, industry, and program participants, the curriculum has been modified to incorporate a major field applications session. The new session is directed at the heart of roadway maintenance operations using improved training methodology for the field crews. This new modified session is considered the capstone of the ESA Best Management Practices. **The new session, Track 3F, now supplements the former Track 3 classroom session. See the new description of this track below.**

Track 2, the session for managers, engineers, and scientific staff, has also been updated to reflect the U.S. National Marine Fisheries Services (NMFS) articles of approval and to make some minor improvements to the instructional material. Most of the modifications involve minor reorganization of the material and classroom slide presentation.

The University of Washington has completely reviewed the program and analyzed the cost structure based on the modifications and updates, and the restructuring and improving of the field crew session. In addition, there are other cost efficiencies that have been incorporated into the costs for each training track. Fees for each track are part of a legislatively approved agreement for the 2003-05 biennium executed by WSDOT with the University of Washington. The agreement provides partial

funding to help maintain the low tuition rates. These rates, shown below, are for public agencies only. Private sector rates can be obtained by contacting the University's program coordinator Julie Smith (phone and e-mail below).

ESA Training Tracks

Tracks 2, 3, and 4 are part of the Training Plan.

- **Track 1: Briefing for Regional Decision Makers**
2 hours. No fee. An overview of the ESA program for regional level management and administration. This is a stand-alone training class and not part of the required training program. It is offered by members of the Regional Road Maintenance Forum. Call Roy Harris or Gerry Crum, City of Everett, at (425) 257-8800 for information. Information may also be obtained from Janine Johanson at METROKC, (206) 205-7101.
- **Track 2: Introduction, Design and BMP's: Monitoring, and Environmental Roles for Technical and Scientific Staff**
1.4 CEUs. Tuition is \$225. This two-day course is an overview of the procedures for technical, professional and environmental staff, supervisors and leads involved in maintenance activities. This track provides an introduction to the program Guidelines, design, habitat, the ten program elements and maintenance Best Management Practices (BMPs) to meet ESA requirements.
- **Track 3: Classroom Introduction to ESA and Outcome-based Road Maintenance for Field Crews**
0.7 CEUs. Tuition is \$165. This one-day course is an overview of the procedures for field crews and leads involved in maintenance activities. This track provides an introduction to the program Guidelines, design, habitat, environmental roles, the ten program elements and implementation of maintenance BMPs to meet ESA requirements.
- **Track 3F: Classroom Introduction to ESA and Outcome-based Road Maintenance for Field Crews and Crew Training in the Field Environment: Applying Maintenance BMP's**
0.7 CEUs. Tuition is \$140. This one-day course is an overview of the procedures for field crews and leads involved in maintenance activities. This track provides an introduction to the program Guidelines, habitat, and is conducted in a field setting where teams of maintenance crews construct, test, and assess the effectiveness of a variety of BMPs. Participants will also learn how to monitor each BMP and measure its outcome in comparison to the outcome goals established in the approved program.

■ Track 4: Train-the Trainer for the Regional Road Maintenance Program

1.4 CEUs. Tuition is \$240. For agency-selected ESA trainers. This two-day course focuses on training skills and techniques, and evaluates, prepares, and certifies candidates to teach the Regional Road Maintenance Program classroom training (Tracks 2 and 3).

ESA Program Approved by U.S. NMFS

Over three years of dedicated effort of the U.S. National Marine Fisheries Service (NMFS) and the Puget Sound Regional Forum culminated on August 15, 2003, when the Regional Road Maintenance ESA Program was approved by NMFS. The program was approved on the condition that all program elements are implemented by agencies seeking approval for routine road maintenance activities. An important program element is the Regional Road Maintenance training program that was launched in spring 2002. Since then, about 1,200 maintenance supervisors, engineers, environmental staff, crew leads, and maintenance crew members have been trained. The initial series of classes were scheduled primarily for agencies that had committed to the Regional Road Maintenance Program (RRMP) Guidelines and had submitted a "Part 3 Application." The training is now available for anyone requesting it. The goal of the program remains to serve all maintenance personnel who want to expand their roadway maintenance knowledge and skills, and in particular, learn more about BMPs in roadway maintenance.

The Part 3 Application is an agency commitment to the ten program elements (of which the training program is Element #3), and can be obtained from the following web site: <http://www.metrokc.gov/roadcon/bmp/pdfguide.htm> or by contacting Janine Johanson at (206) 205-7101. The ultimate goal is to have all agency roadway maintenance personnel trained with approved Part 3 Applications on file.

Looking to the Future

During the past year, the Regional Road Maintenance training program has been focused on the ESA issues related to fish species in the Puget Sound Region. The training has been conducted in many locations, such as Jefferson County. In addition, the University of Washington has been asked to furnish instructional assistance by teaming with new Track 4-trained instructors who are beginning to train within their agencies. This instructional support has been quite successful and is expected to be an ongoing asset to agencies seeking supplemental and/or updated program information after their initial training has been completed.

The training program may also have far wider applications and venues. These procedures were developed to provide a comprehensive outline of effective management practices applicable in any area or maintenance setting. The training is thus appropriate for all roadway agencies that seek to implement a consistent roadway maintenance program that is environmentally and ecologically sound and provides a solid structure for good roadway maintenance practices.

Modified Tuition Rates

Agencies can now lower the training costs for its participants by providing a classroom facility / field site and equipment, and covering costs for instructional handouts for a full class. Those interested in exploring this option should contact Julie Smith (phone and e-mail below).

The Civil and Environmental Engineering Department's Transportation Professional Development Program at the University of Washington is responsible for developing, coordinating and presenting the ESA program courses.

For course material information, contact Jim McManus, the Director of Professional Development, at (206) 543-3747 or jmcman@u.Washington.edu.

For program information or course registration, contact Julie Smith at (206) 543-5539 or jsmith@engr.washington.edu.

Program and registration information can also be found at <http://www.engr.washington.edu/epp/esa/reginfo>.

TRANSPEED University of Washington

Contact: Christy Roop Pack
(206) 543-5539, toll free 1-866-791-1275
fax (206) 543-2352
<http://www.engr.washington.edu/epp>

To register for a class in this section, use the contact listed above.

The prices in this section are for local agency / non-local agency.

Traffic Calming Techniques and Management

May 3-5, Seattle. \$370 / \$570.

Managing Consultants

May 11, Lacey (web-based begins April 20). \$485 / \$650.

Traffic Signal Design

May 26-28, Seattle. \$400 / \$585.

Traffic Engineering Operations

June 9-11, Lacey. \$320 / \$520.

Engineering Professional Programs (EPP) University of Washington

Contact: Emily West
(206) 543-5539, fax (206) 543-2352
<http://www.engr.washington.edu/epp>

To register for a class in this section, use the contact listed above.

Cold Regions Engineering Short Course

May 13-19, Seattle. \$1,295 early registration,
\$1,355 late registration.

Engineering Refresher Courses

Three evening courses provide thorough preparation
for state of Washington engineering examinations.

■ **Fundamentals of Engineering Exam Review/ E.I.T.**

September 8-October 18, 2004
Mondays and Wednesdays, 6:30 to 9:00 p.m.

■ **Mechanical Engineering Review Course**

September 9-October 19, 2004
Tuesdays and Thursdays, 6:30 to 9:00 p.m.

■ **Civil Engineering Review Course**

September 14-October 19, 2004
Tuesdays and Thursdays, 7:00 to 9:30 p.m.

Professional Engineering Practice Liaison (PEPL) University of Washington

Contact Stephanie Storm
(206) 543-5539, fax (206) 543-2352
<http://www.engr.washington.edu/~uw-epp/>

To register for a class in this section, use the contact listed above.

Project Leadership Workshop

May 12-13, Seattle. \$655 before April 28,
\$685 thereafter.

Geology and Geomorphology of Stream Channels

May 18-19, Seattle. \$495 before May 4, \$530 thereafter.

AASHTO Roadside Design Guide, Web Based Training

NHI Course Number: 380032C

This web-based course is approximately 14 hours long and is available anytime – 24 hours, 365 days a year via the Internet. The cost for non-FHWA employees is \$230 per participant and includes a copy of the 2002 AASHTO "Roadside Design Guide." This course provides an overview of the 2002 AASHTO "Roadside Design Guide." Emphasis is on current highway agency policies and practices. Participants must register online at <http://www.nhi.fhwa.dot.gov/registerdl.asp>

Computer Requirements: You will need a fairly recent version of a browser (such as Internet Explorer 4 or 5 or Netscape 4 with JavaScript enabled), the latest version of Macromedia Shockwave and Flash (which you can download from the Internet), and a connection to the Internet (at least 56K modem). An older computer such as a Pentium 100 would work, but it would be slower than a Pentium III. For more information, visit <http://www.nhi.fhwa.dot.gov>

Associated General Contractors (AGC)

Contact Beth Sachse
(206) 284-4500, fax (206) 284-4595
bsachse@agcwa.com
<http://www.constructionfoundation.org>

To register for a class in this section, use the contact listed above.

Construction Site Erosion and Sediment Control Certification

These WSDOT approved classes are presented by the AGC Education Foundation and available on the following dates:

May 12-13, Seattle; June 2-3, Tacoma; June 23-24, Seattle.

- Recertification requires attendance on Day 1 only, successfully completing exam, and proof of previous WSDOT certification. \$200
- Certification training lasts a day and a half and requires successfully completing end of course exam. \$275

AASHTO 2004 Conference for Right of Way and Utilities

May 9-13, 2004, Seattle Sheraton Hotel, Seattle. \$275.
For more information, see <http://www.wsdot.wa.gov/realestate/aashto/>.

Pacific Northwest Transportation Technology Expo

May 18-19, 2004, Grant County Fairgrounds, Moses Lake, Wash.
Contact the WST2 Center at (360) 705-7386.

Pacific Northwest Snowfighters

June 9-11, 2004, Ag Trade Center, Spokane, Wash.
Sponsored by Washington State University.
Contact information available at 1-800-942-4978 and <http://capps.wsu.edu/pns/>.

2004 Road and Street Maintenance Supervisor's School

East: October 5-7, 2004, Mirabeau Park Hotel, Spokane Valley, Wash.

West: December 8-10, 2004. DoubleTree, Bellevue, Wash.

For more information, contact Kelly Newell at Washington State University at 1-800-942-4978.

Northwest Pavement Management Association (NWPMA) Fall Conference

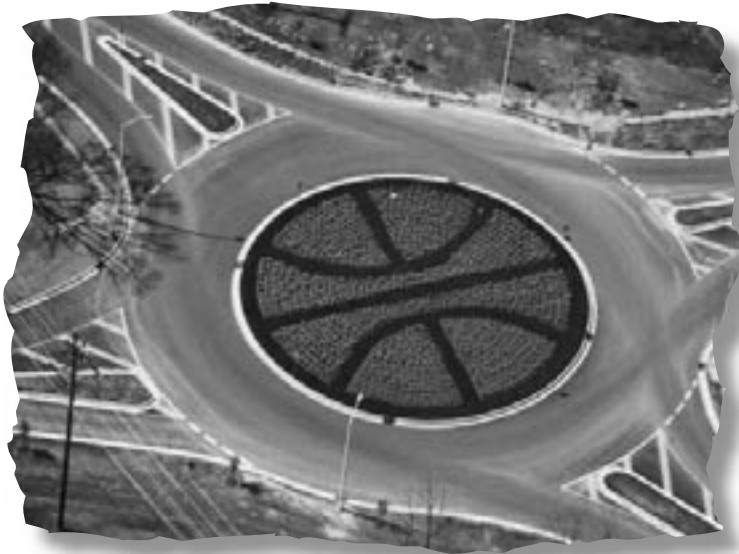
October 18-20, 2004, Sheraton Hotel, Tacoma, Wash.
For more information, contact Bob Brooks at (360) 705-7352 or brookbo@wsdot.wa.gov.

APWA Washington State Chapter Conferences – Fall 2004

October 19-22, 2004, Kennewick, Wash.
For more information, contact Bill Goodwin at (425) 741-5026.

Idaho Asphalt Conference

October 21, 2004, Moscow, Idaho
Contact University of Idaho Conference Services at 1-888-884-3245.



In keeping with March Madness, that sacred time of year, and the NCAA 64 team tournament, this particular roundabout in Bloomington, Indiana (where else would you expect this tribute to one of America's favorite sports?), has an appropriately landscaped central island. Many thanks to the City of Bloomington and the designer of the roundabout, not to mention the greenskeeper who has to keep this basketball looking good and game ready.

One of the goals of the WST2 newsletter is to be an electronic publication. You can access the newsletter at <http://www.wsdot.wa.gov/TA/T2Center/T2HP.htm> and then click on WST2 Newsletter under Publications and Software.

If you would like to stop receiving a hardcopy of the newsletter, please e-mail Wendy Schmidt at schmidw@wsdot.wa.gov, and ask to be taken off the mailing list.



Sign of the Times

Do you have a humorous traffic sign to share? Send us a print or e-mail a digital image (preferably a 300 dpi, 1000x1500 dpi jpeg or tif) and we will add it to our collection for publishing. Please provide your name, title, agency or company, and a short description of where and when you saw the sign. We want to give you credit for your participation.

You can e-mail the image to schofil@wsdot.wa.gov

Or mail the photo to:
"Sign of the Times"
WST2 Center
PO Box 47390
Olympia, WA 98504-7390

Please don't send your original photo. Although we will do our best to return the photo, we can't guarantee it.

Washington State Technology Transfer

Washington State T2 Staff

Brian Walsh, P.E.

Technology Services Manager
walshb@wsdot.wa.gov
(360) 705-7387

Larry Schofield, P.E.

Technology Transfer Engineer
schofil@wsdot.wa.gov
(360) 705-7390

Roger Chappell

Technology Integration Engineer
chapper@wsdot.wa.gov
(360) 705-7539

Laurel Gray

Training Program Coordinator
grayl@wsdot.wa.gov
(360) 705-7355

Bob Brooks

Pavement Technology Engineer
brookbo@wsdot.wa.gov
(360) 705-7352

Wendy Schmidt

Training Operations Coordinator
schmidw@wsdot.wa.gov
(360) 705-7386

Washington State T2 Advisory Committee

Bud Cave

Deputy Operations Manager
Clark County
bud.cave@clark.wa.gov

Mike Deason, Vice Chair

Public Works Director
City of Leavenworth
(509) 548-5275

Randy Hart, Chair

Grants Program Engineer
County Road Administration Board
(360) 664-3299

Liana Liu, P.E.

FHWA, Washington State Division
(360) 753-9553

Tom Rountree

Road Maintenance Supervisor
King County DOT/RSD
(206) 296-8196

Cheryl Clark

Group Leader, Development
Pacific NW Region, USFS
(503) 808-2409

Mike Sacco

Maintenance Trainer
WSDOT Eastern Region
(509) 324-6541

Jim Seitz

Transportation Specialist
Association of Washington Cities
(360) 753-4137

Richard A. Swan

Colville Tribal Business Council
Washington Tribal Governments
(509) 634-2214
1-888-881-7684 ext. 2214

Bruce Wagner

Road Operations Division Manager
Pierce County
(253) 798-6051

Dave Zabell

Director of Public Works
City of Bothell
(425) 486-2768

Jack Zeppenfeld

Street Division Supervisor
City of Moses Lake
(509) 766-9224

Associate Members

Joe Bonga

Road Construction/Maintenance
Bureau of Indian Affairs
(503) 231-6712

Kathy Lindquist

Research Implementation Manager
WSDOT Research Office
(360) 705-7976

Richard Rolland

Director
NW and Alaska TTAP
rolland@mail.ewu.edu
(509) 358-2225

WST2 Center

E-mail: WST2Center@wsdot.wa.gov

Home Page: <http://www.wsdot.wa.gov/TA/T2Center/T2hp.htm>



Washington State Technology Transfer Center
WSDOT – H&LP Division
P.O. Box 47390
Olympia, WA 98504-7390

